

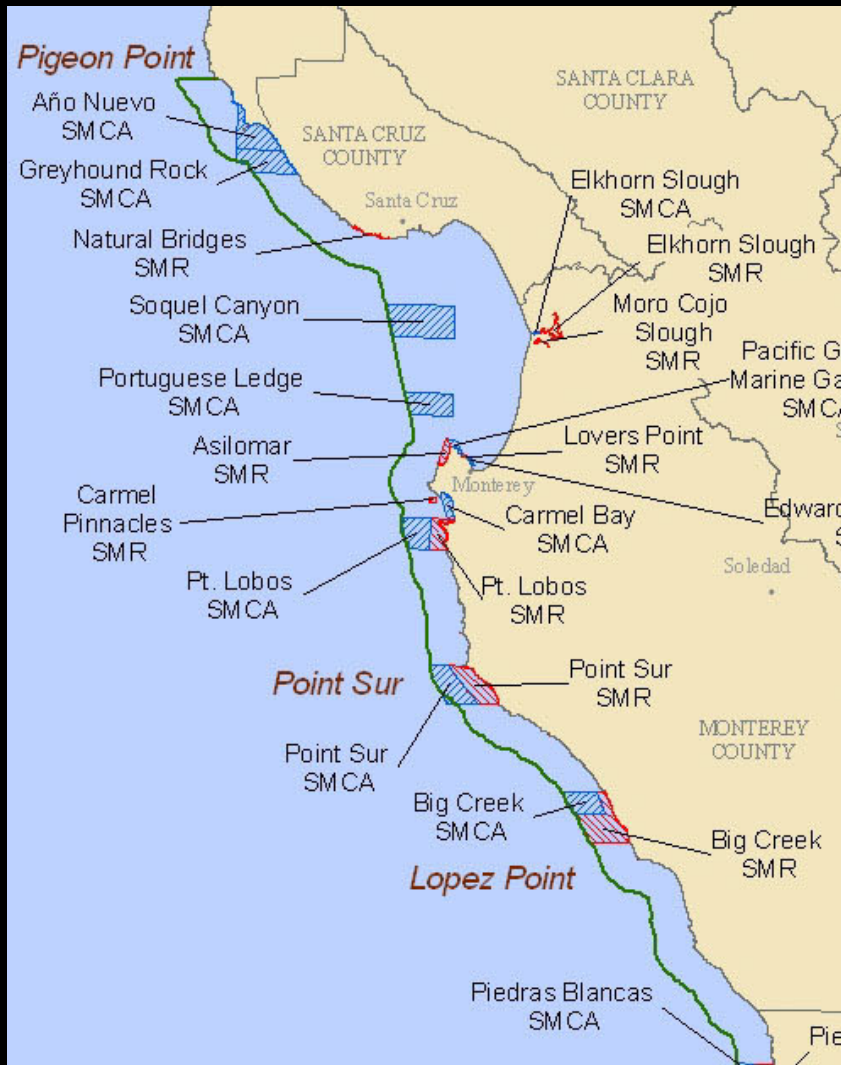
Using climate velocity to guide marine conservation planning

Malin Pinsky

malin.pinsky@gmail.com

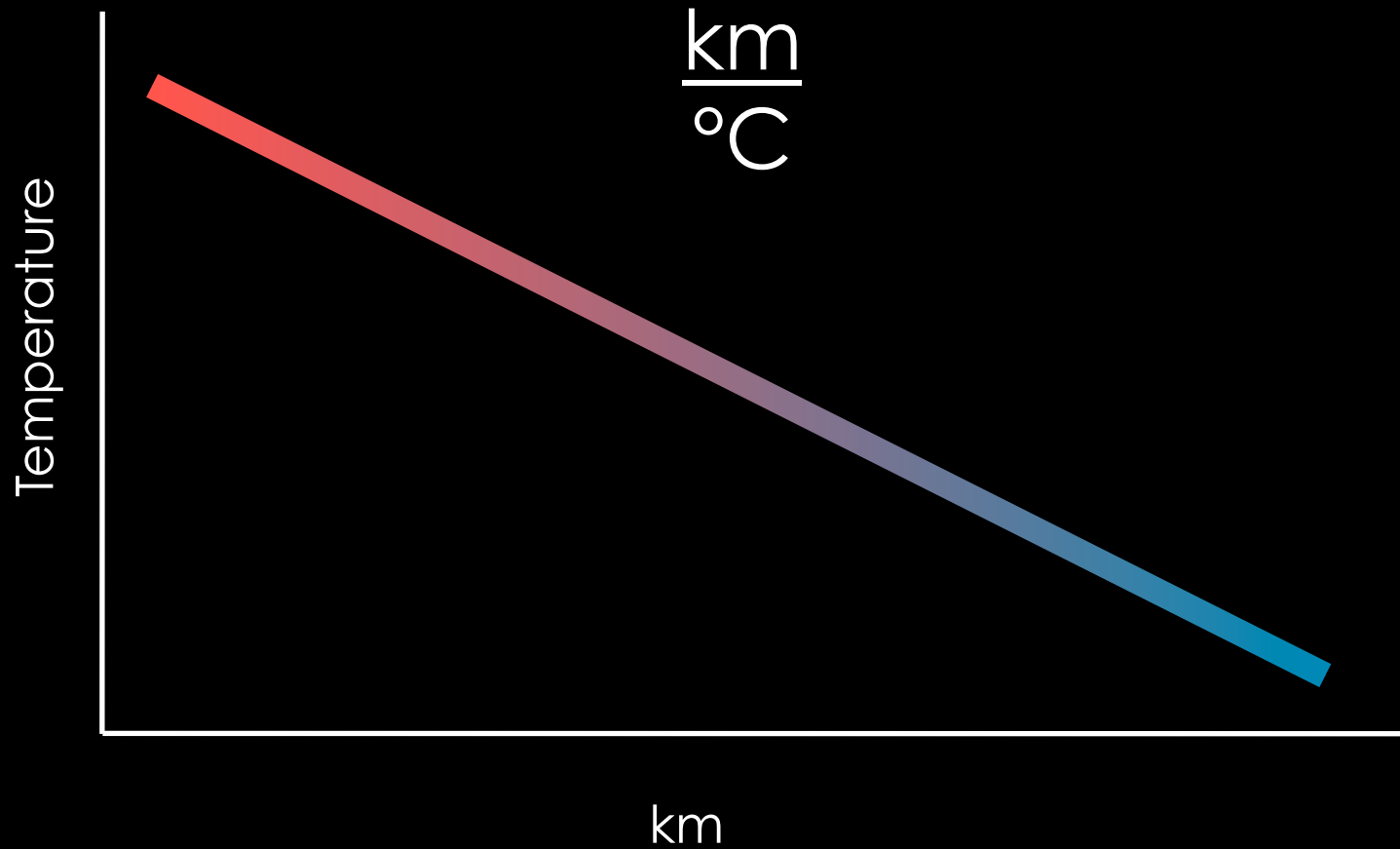


Ready for climate change?

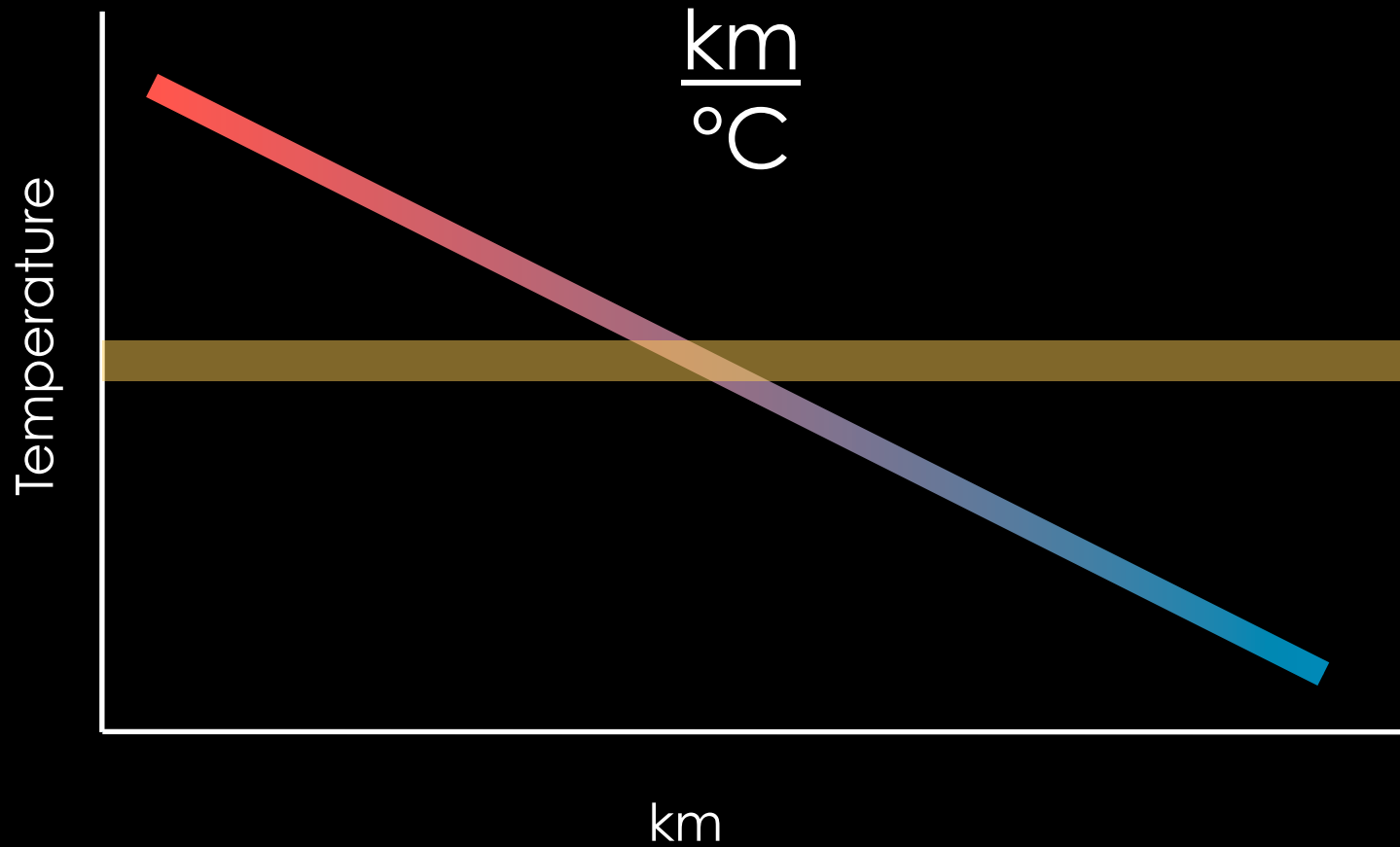


From McCay 2013 *Nature Climate Change*

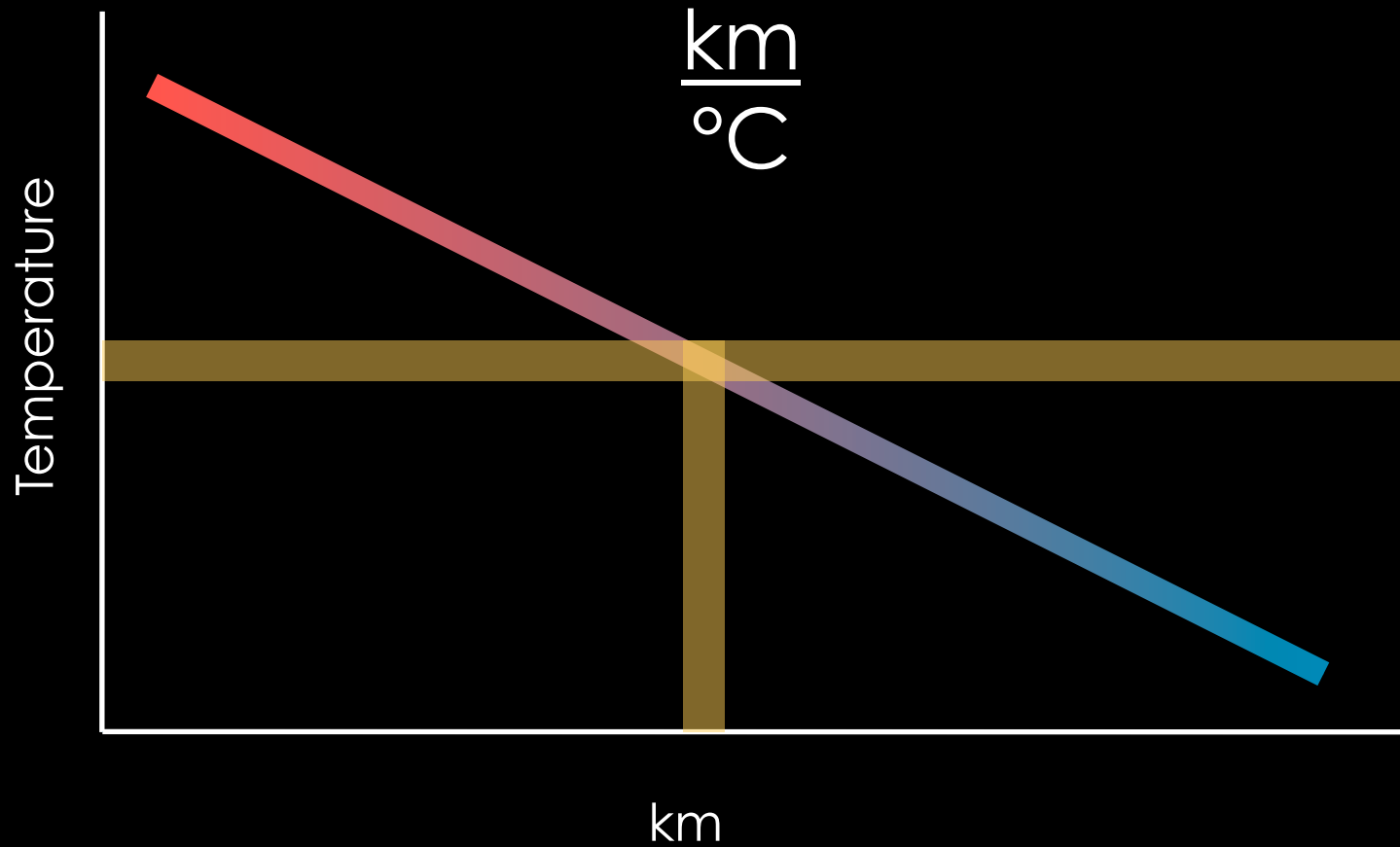
Climate velocity



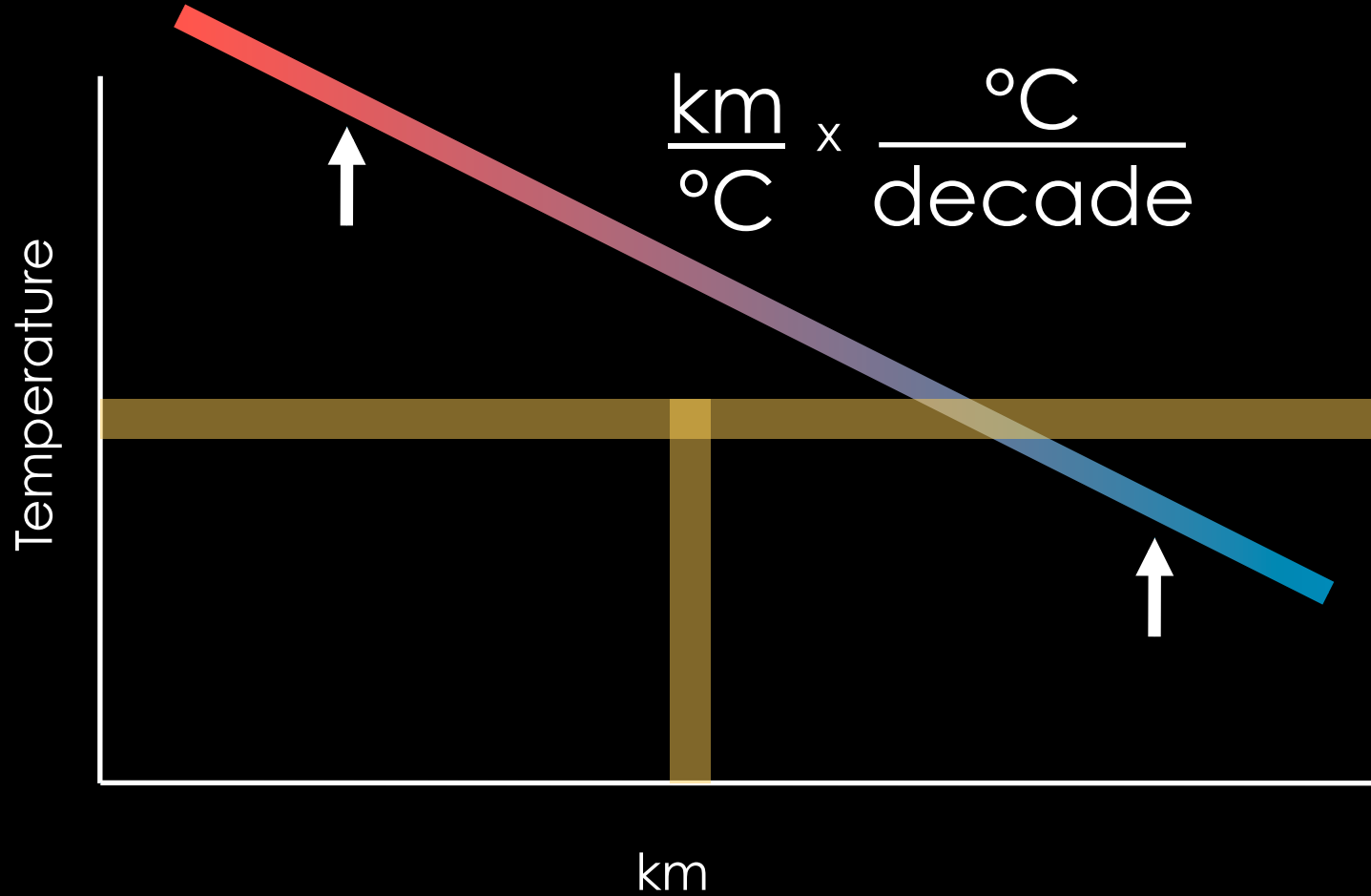
Climate velocity



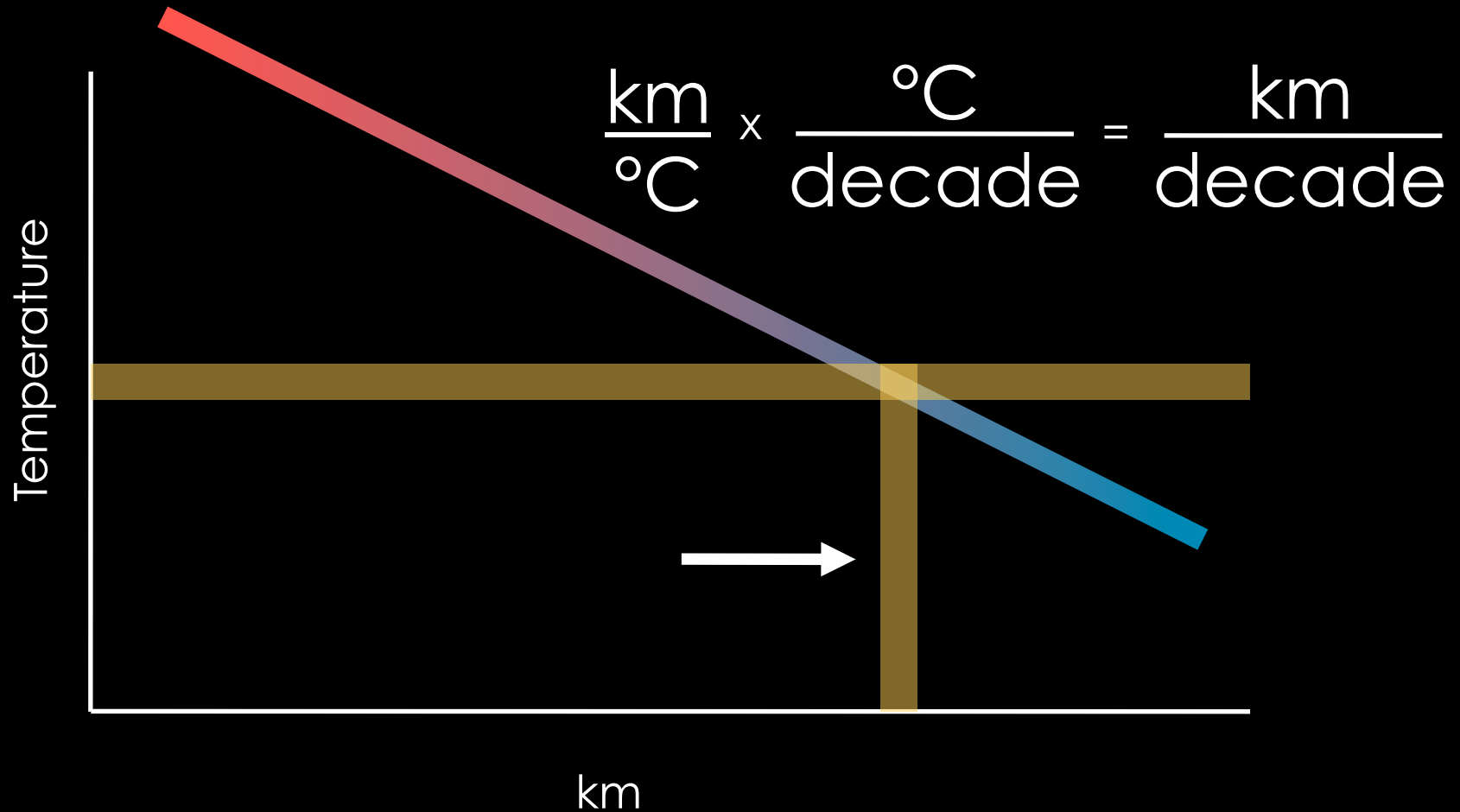
Climate velocity



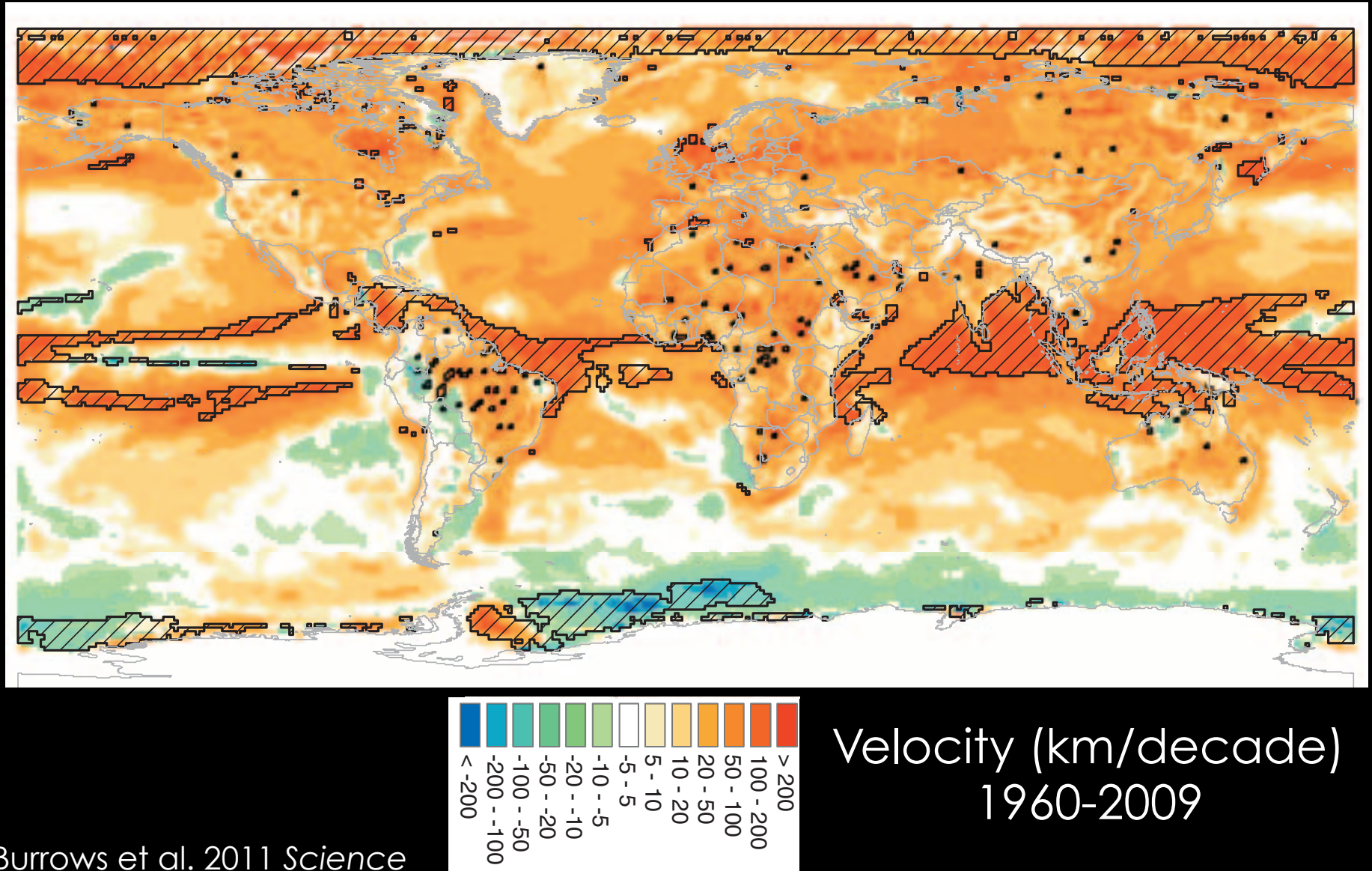
Climate velocity



Climate velocity

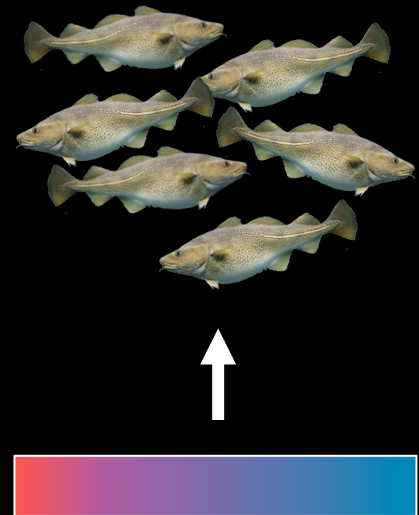


Variation in climate velocity



Outline

- Do species shift with climate?



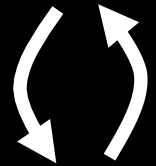
Outline

- Do species shift with climate?
- Are fisheries affected?



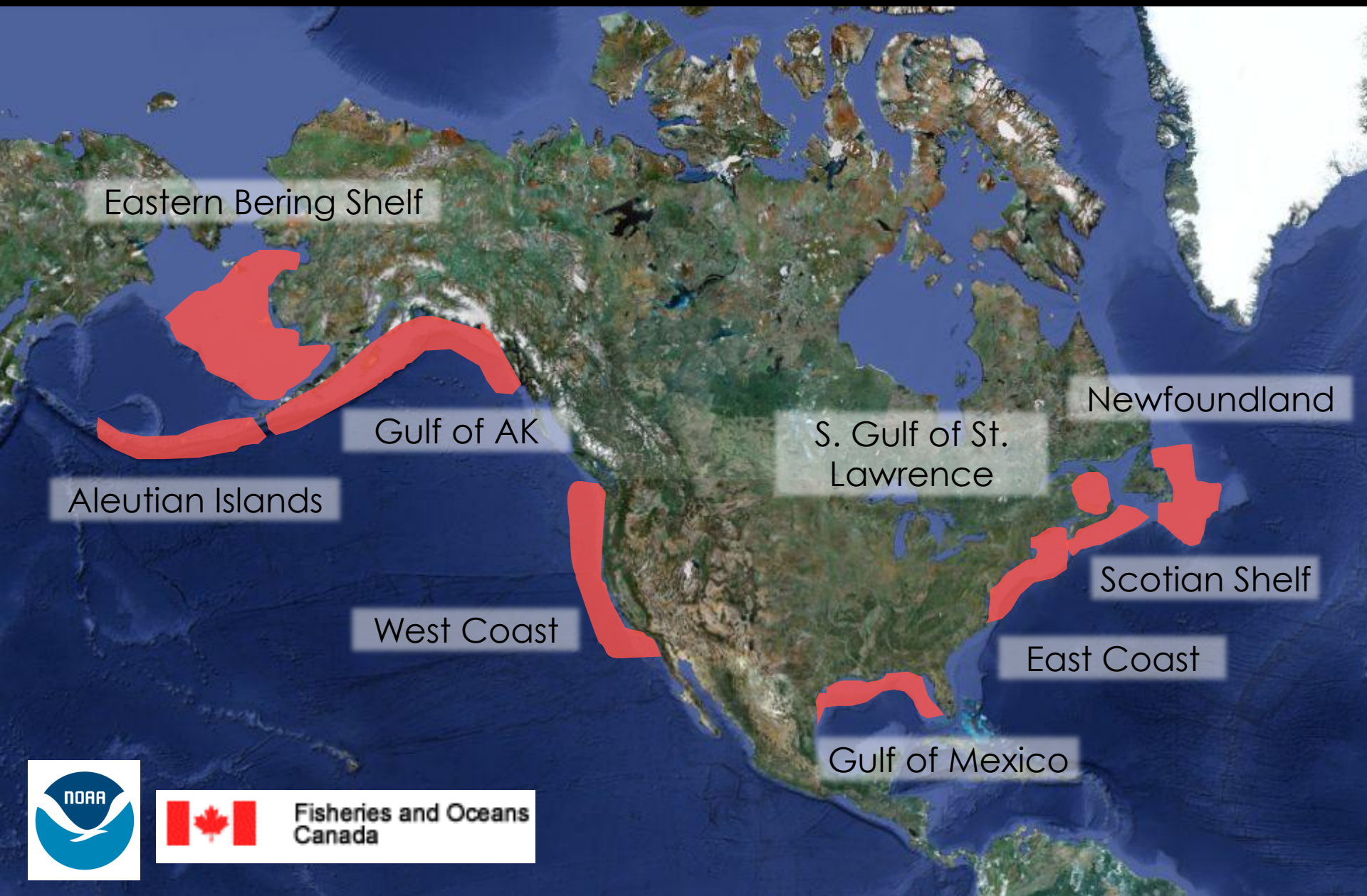
Outline

- Do species shift with climate?
- Are fisheries affected?
- Do fisheries affect range shifts?

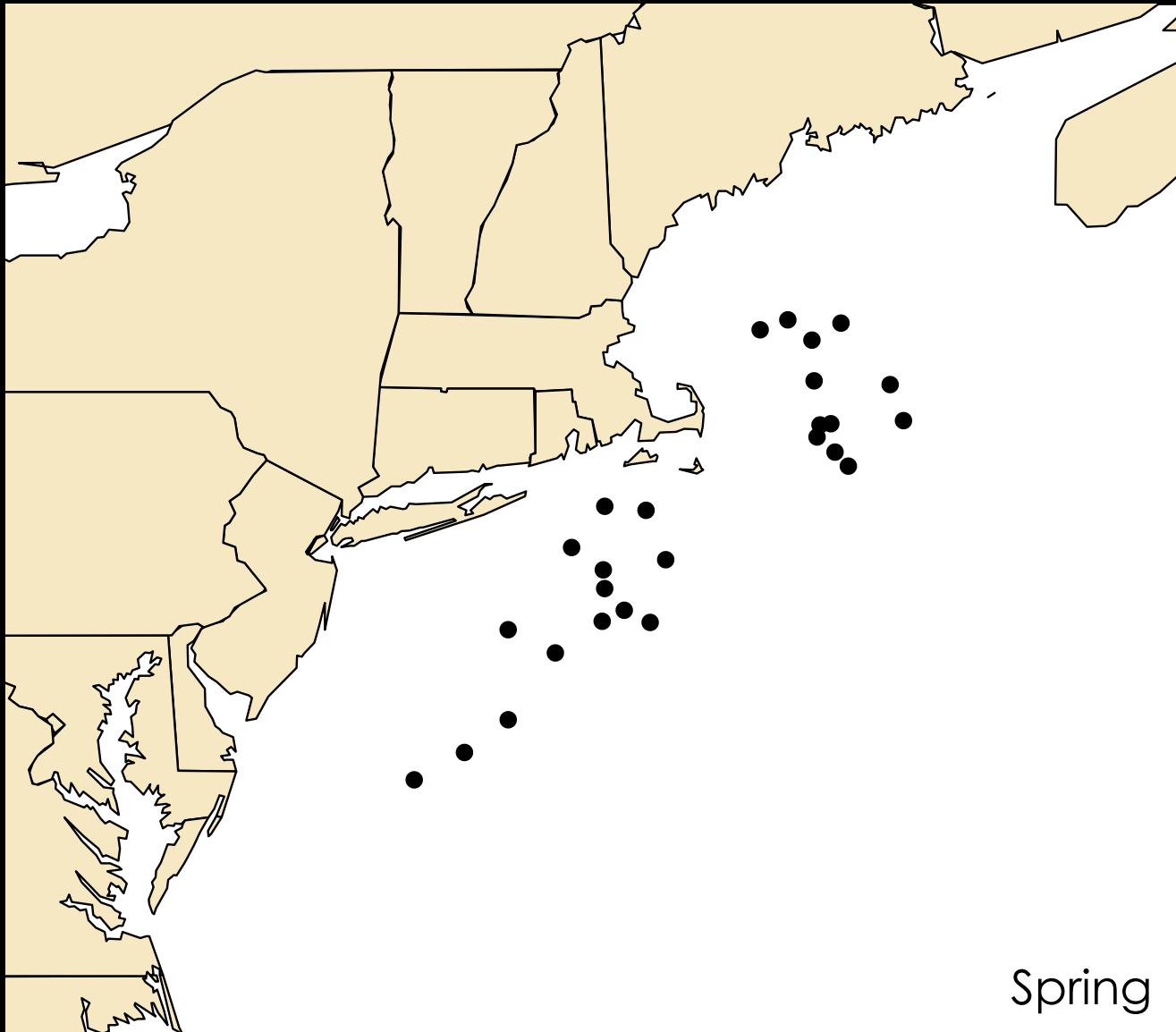


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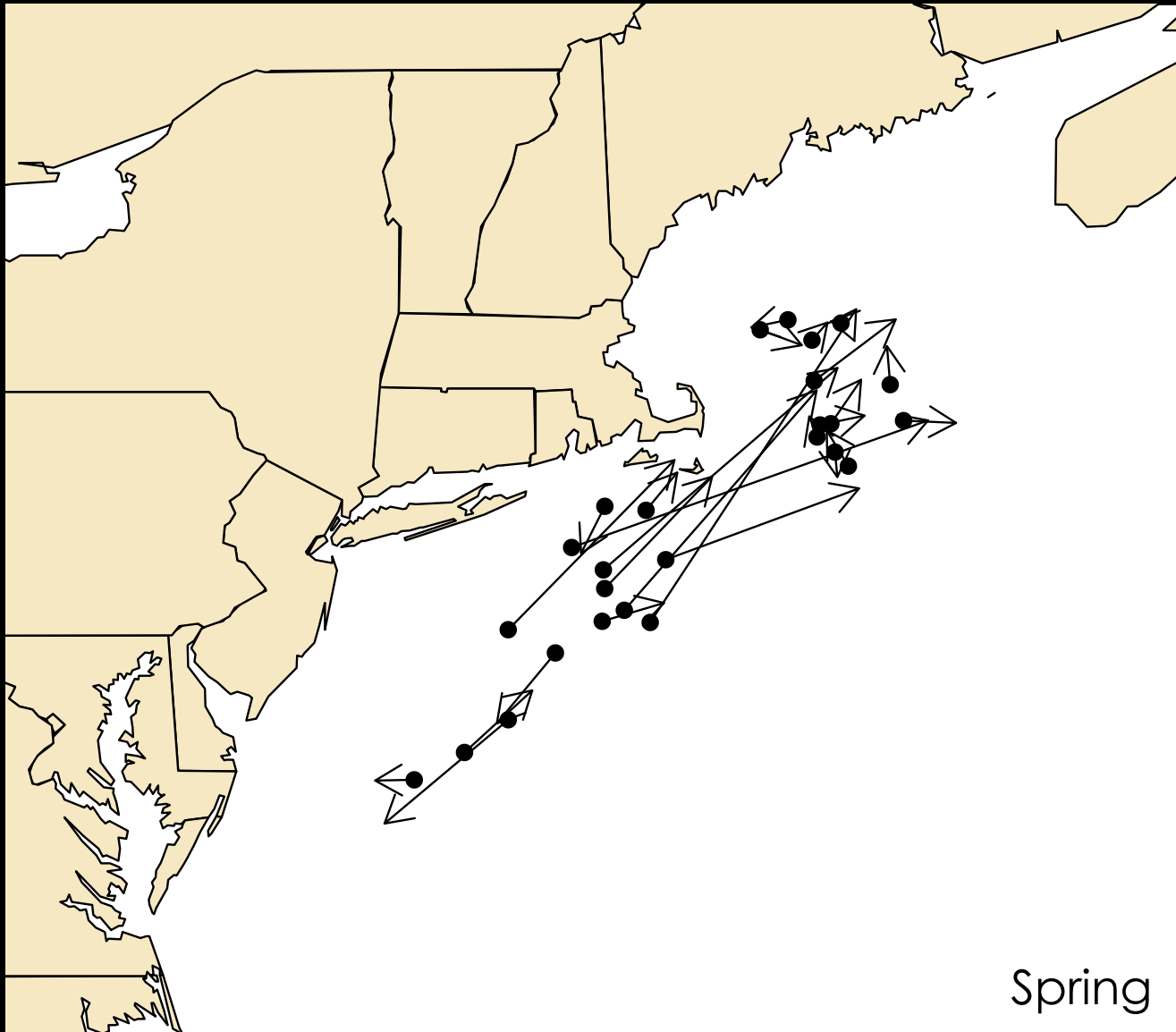


Centers of species' ranges: 1968

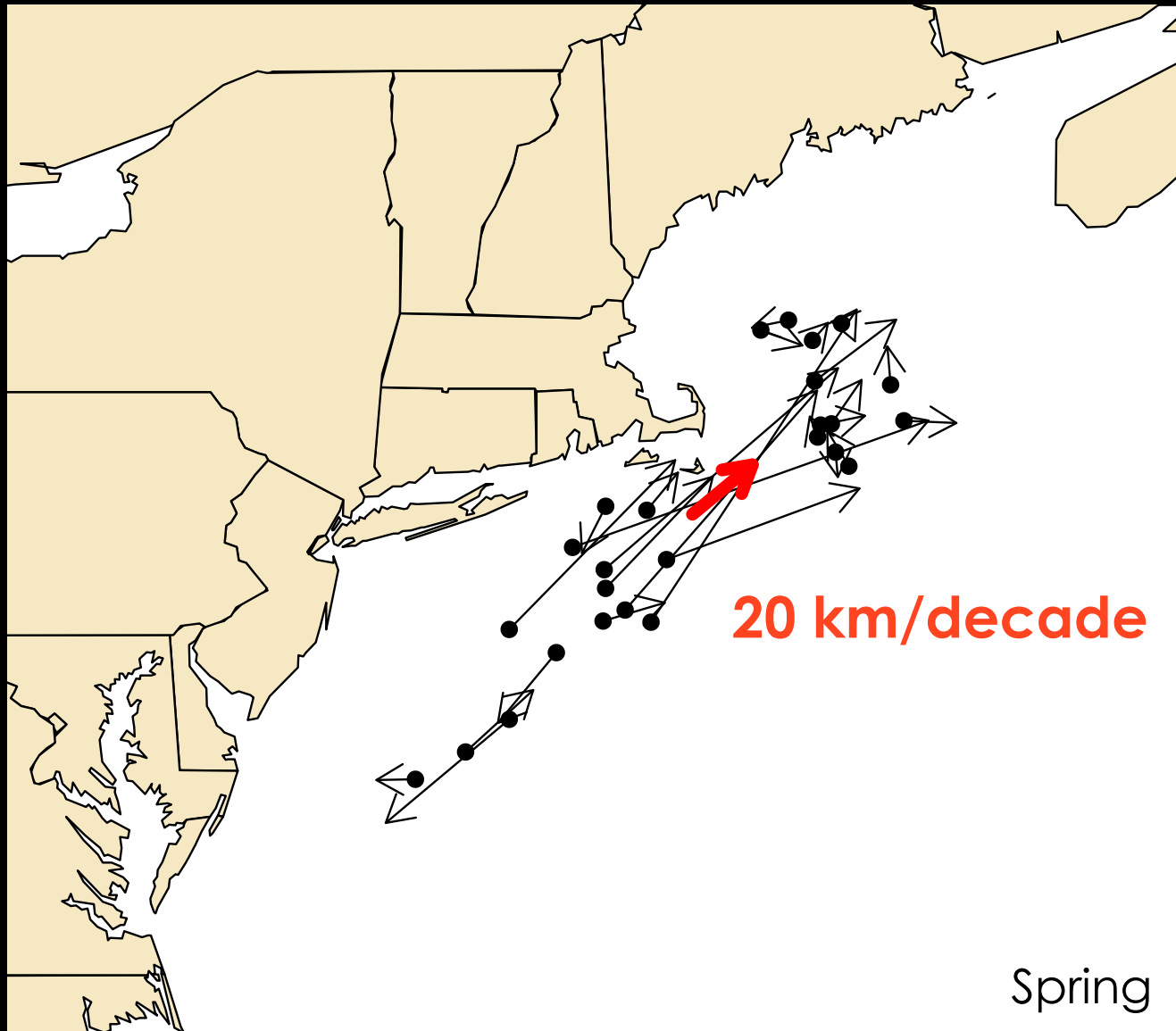


Spring

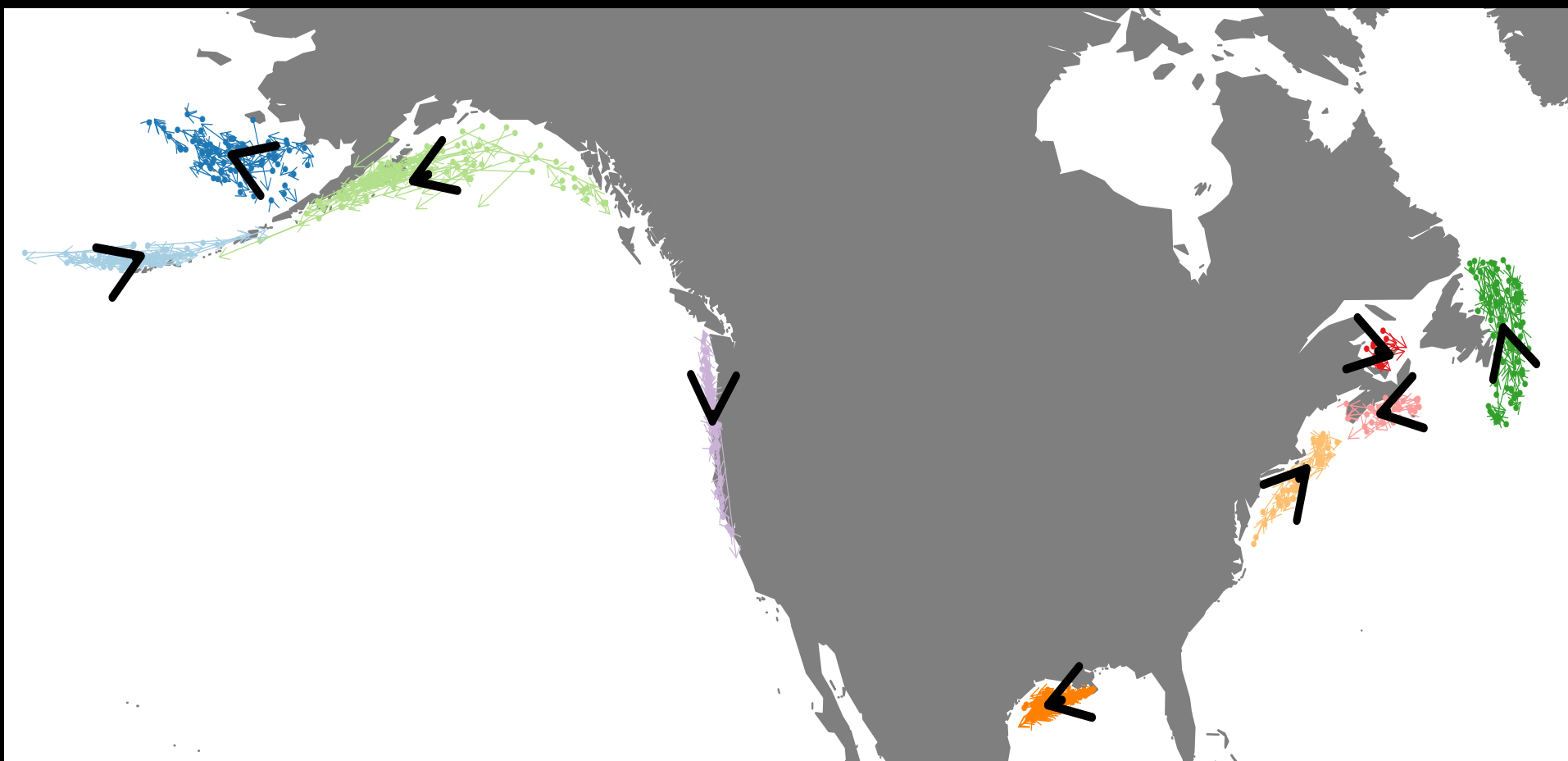
Shifts in centers of species' ranges: 1968-2008



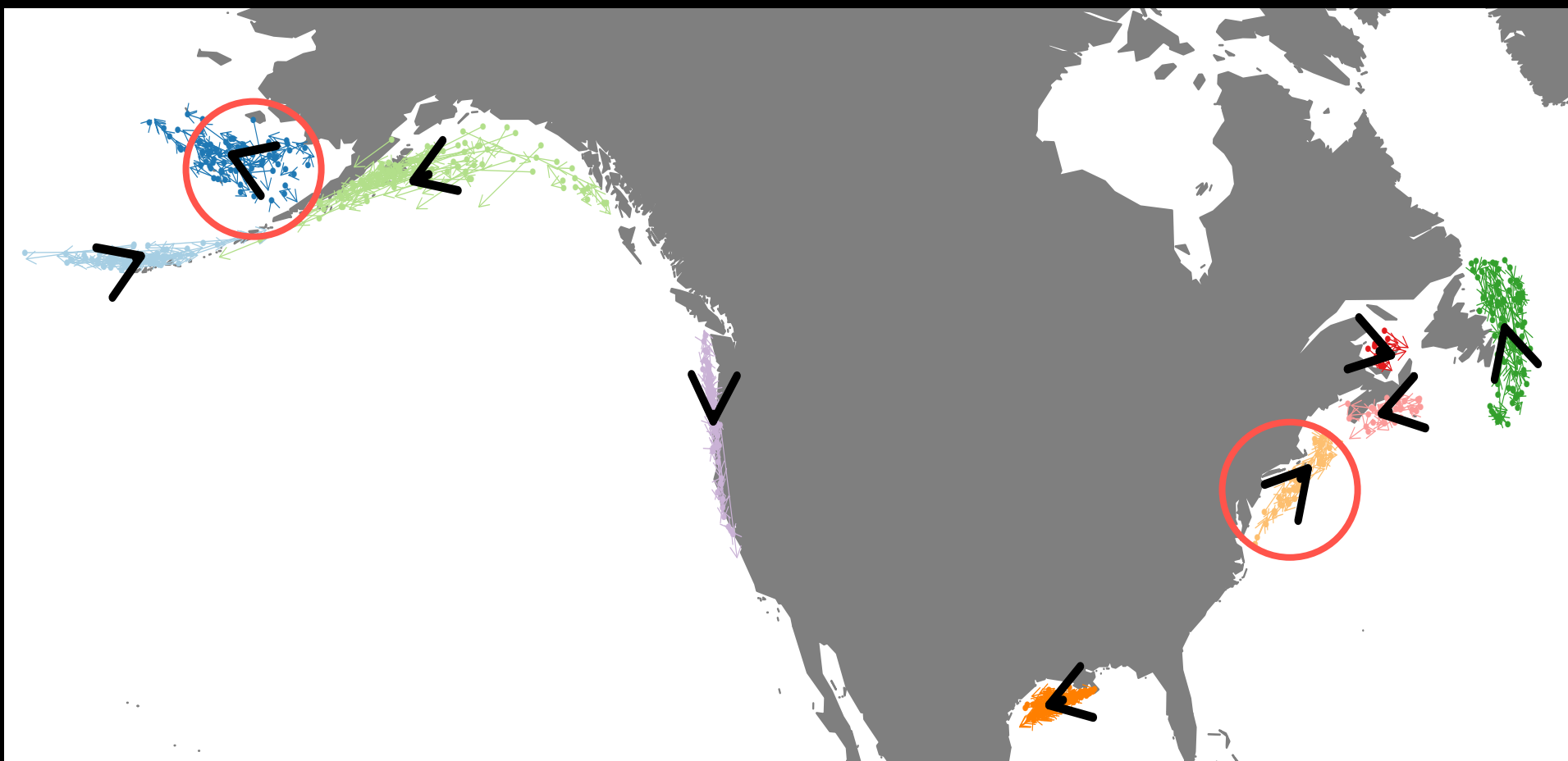
Average shift to the northeast



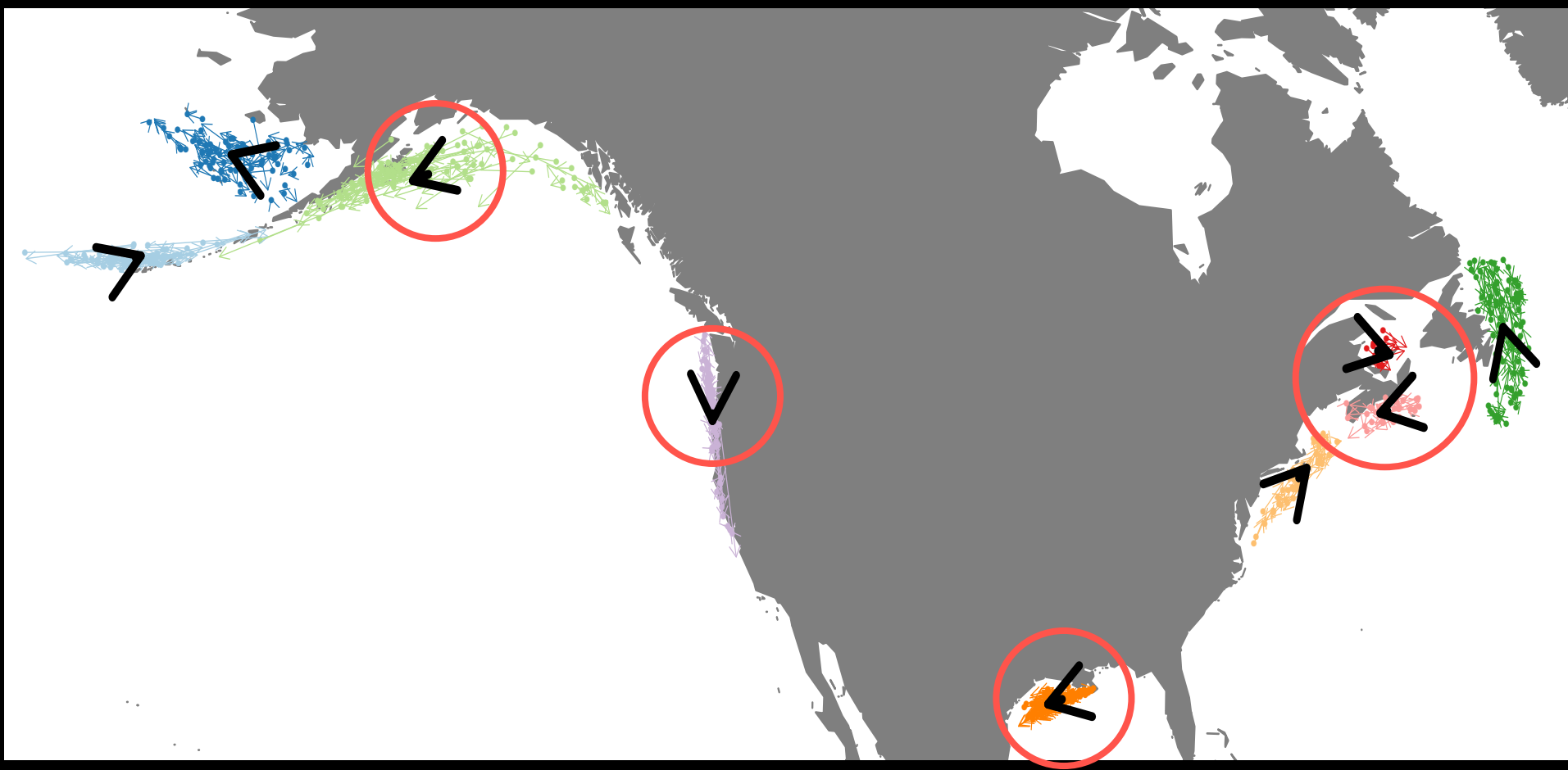
Wide variation in range shifts



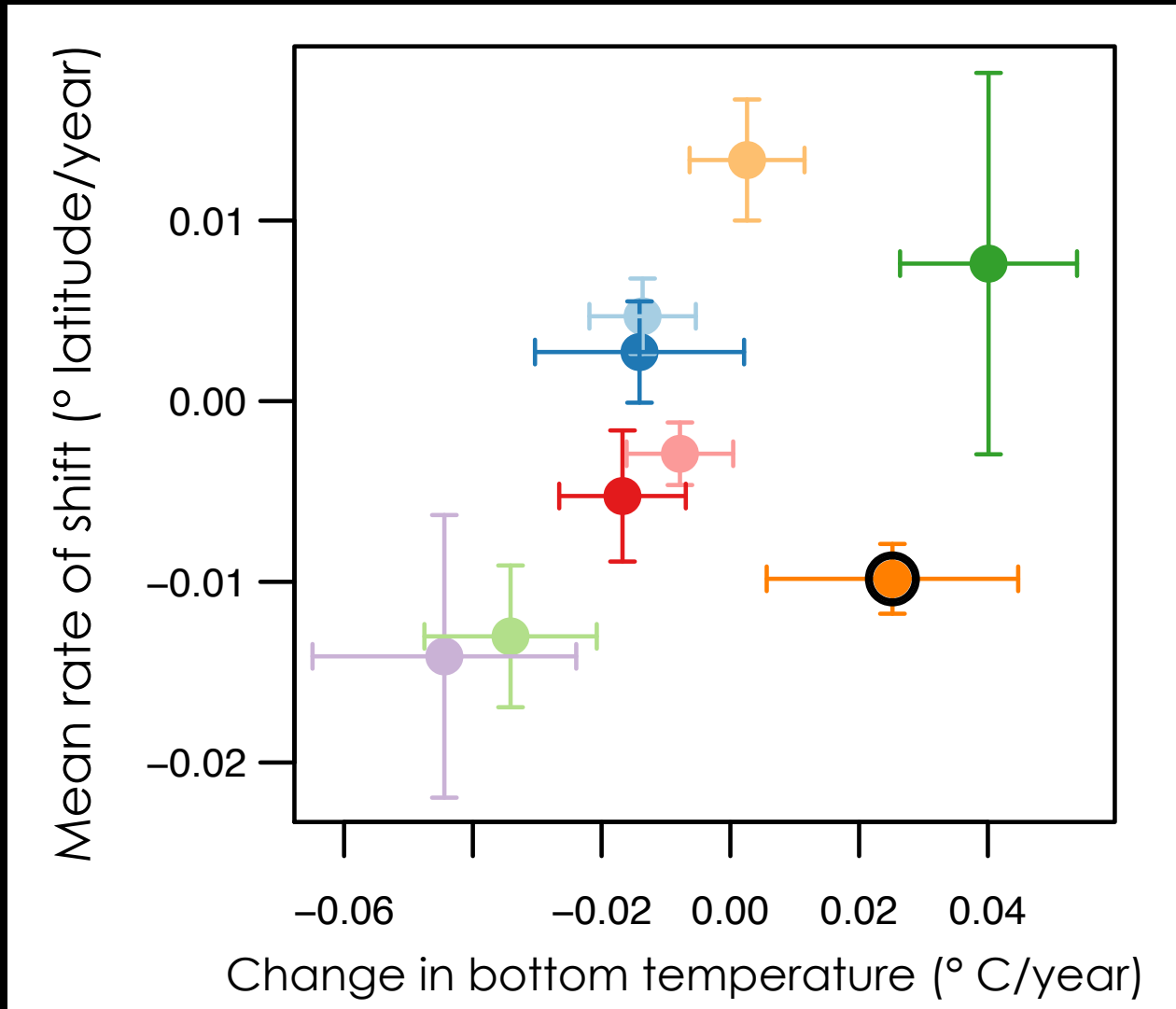
Previously known poleward shifts



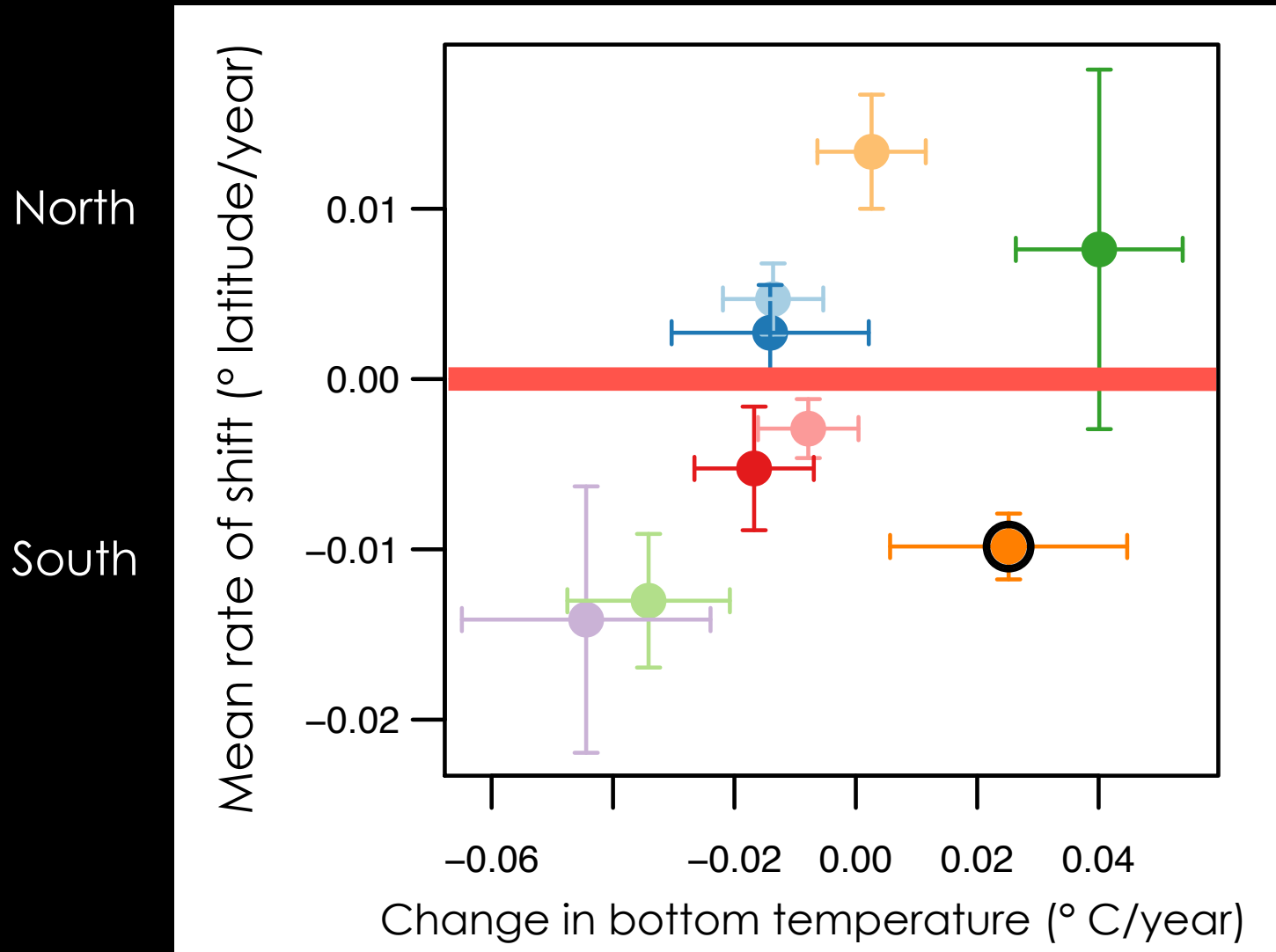
Many regions shifting south



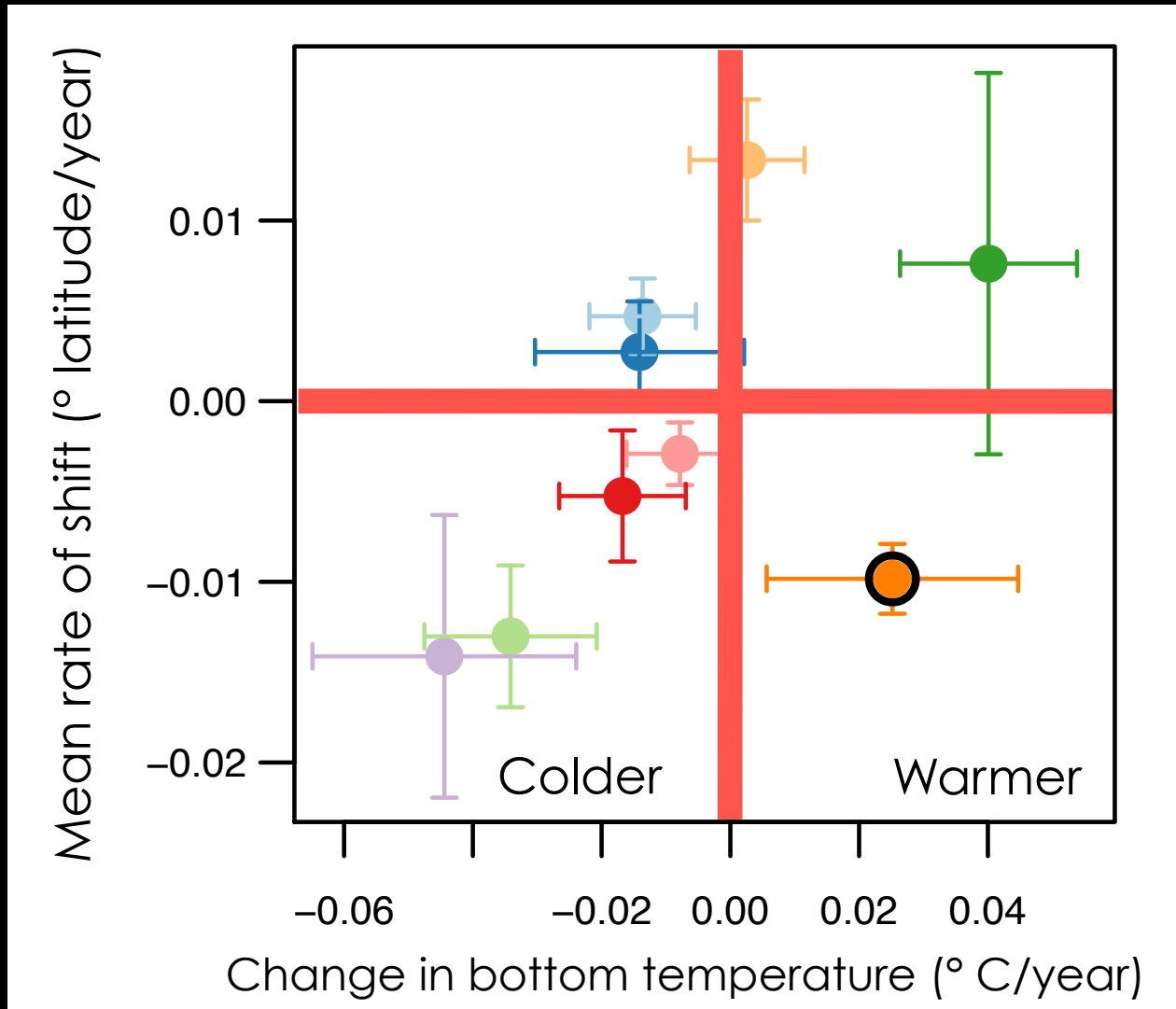
Temperature and regional shifts



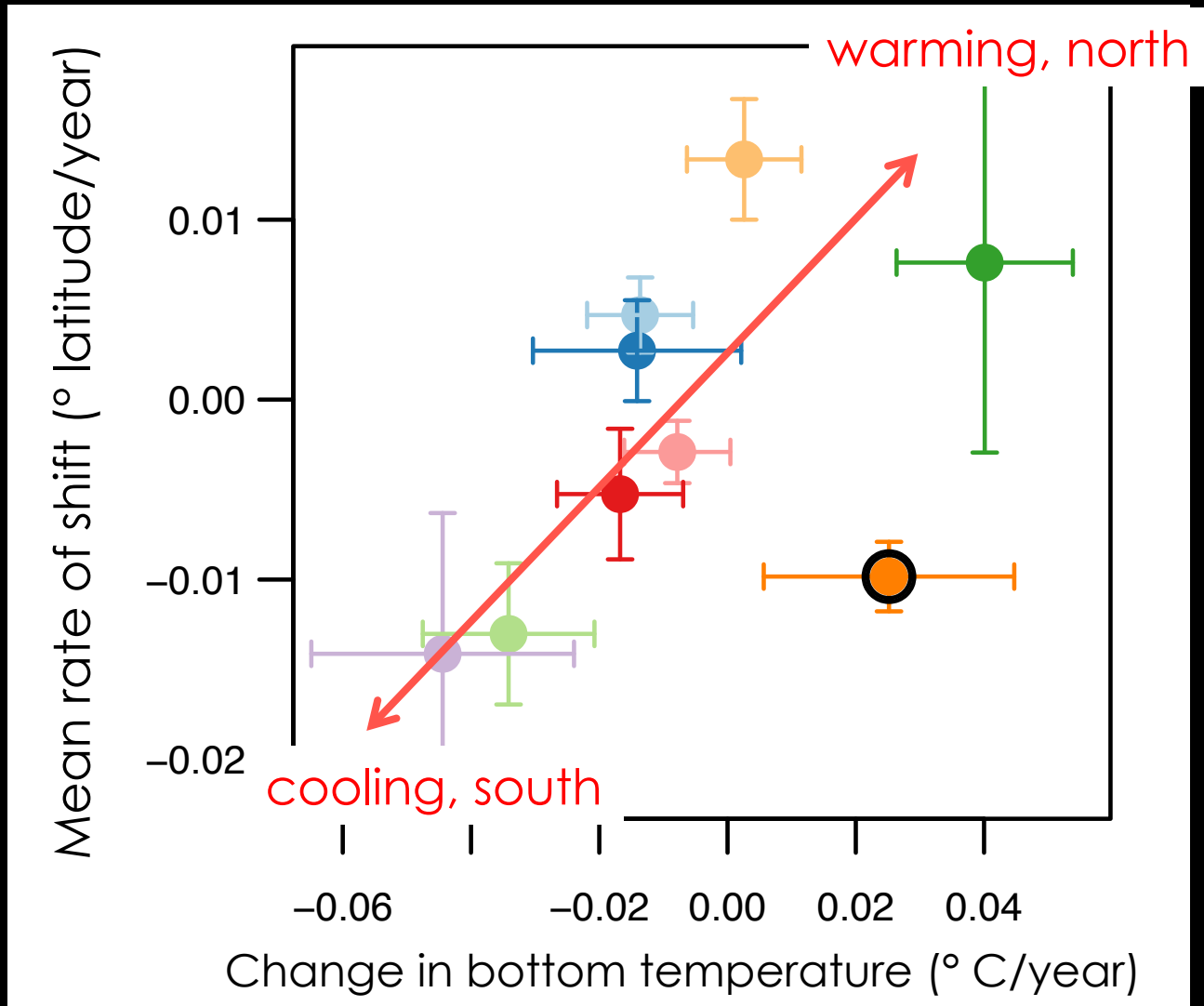
Temperature and regional shifts



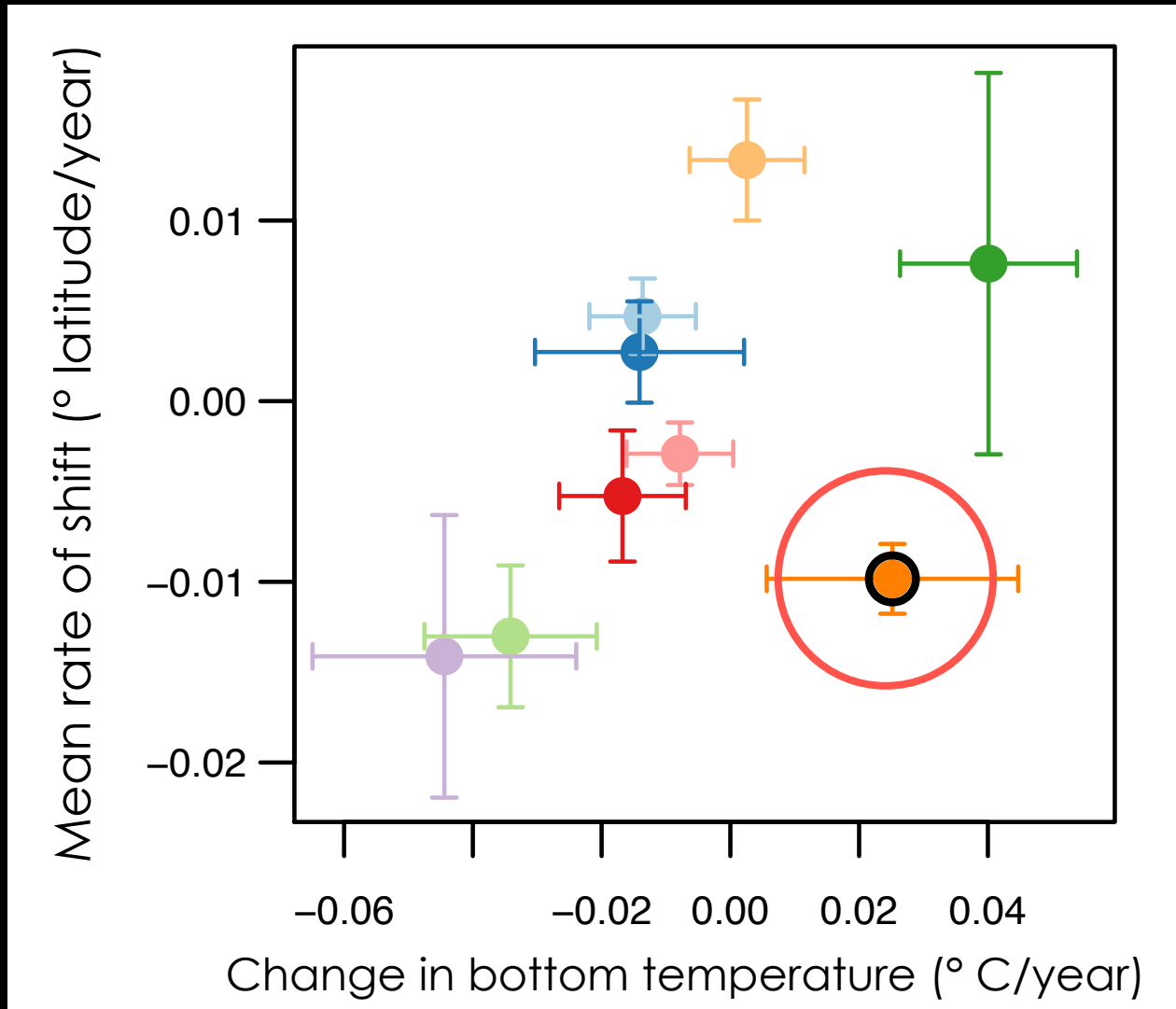
Temperature and regional shifts



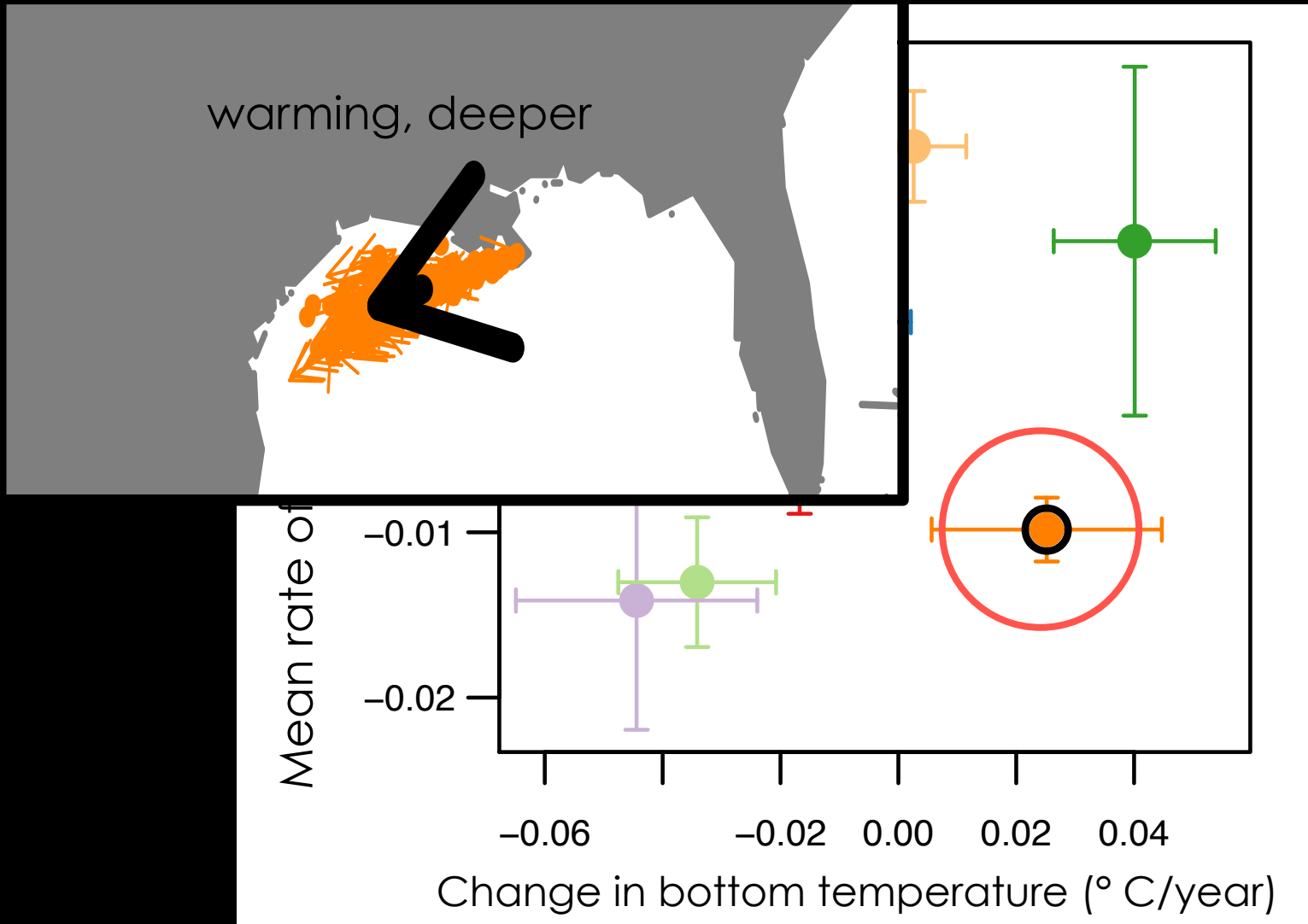
Temperature and regional shifts



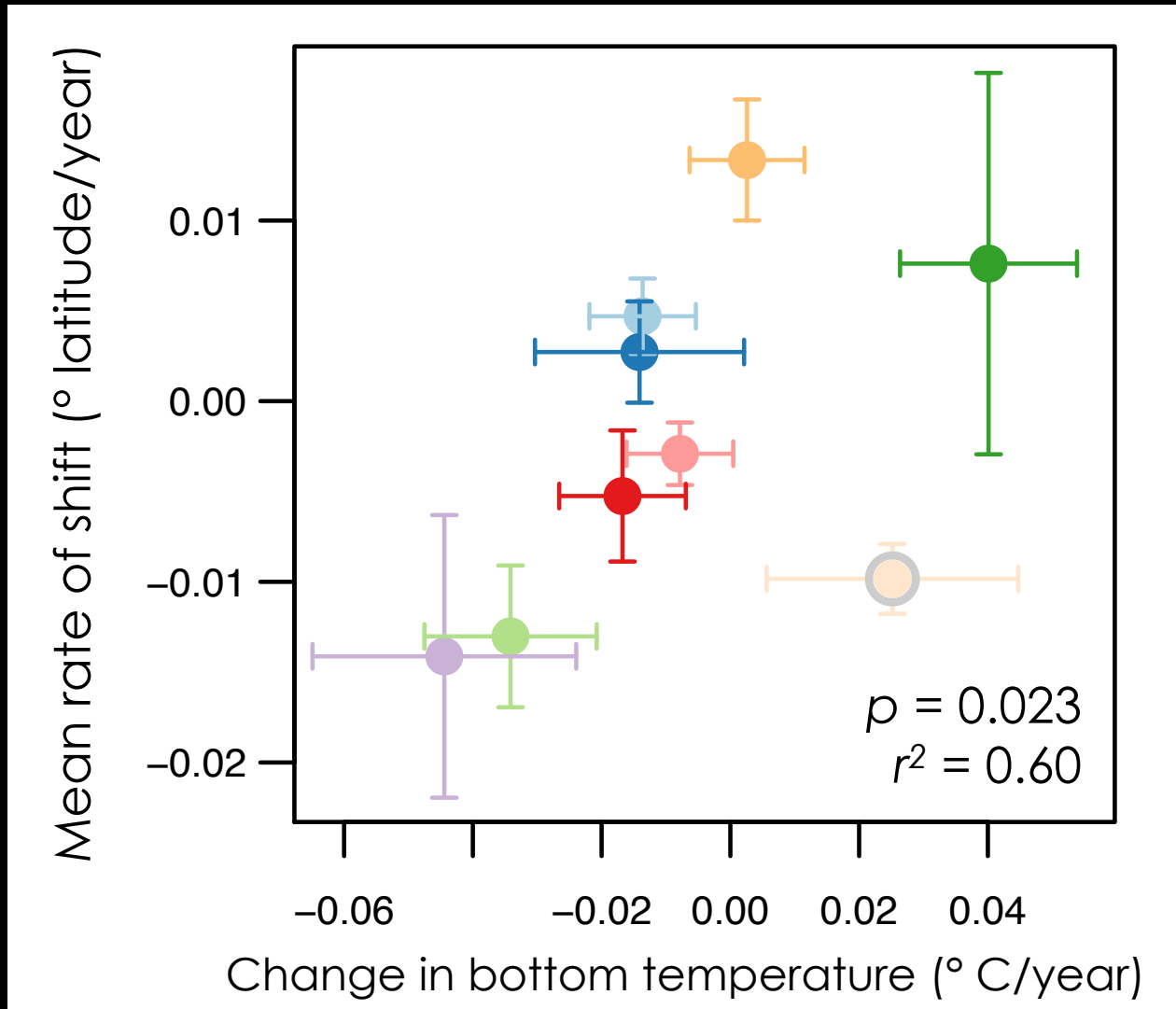
Gulf of Mexico outlier



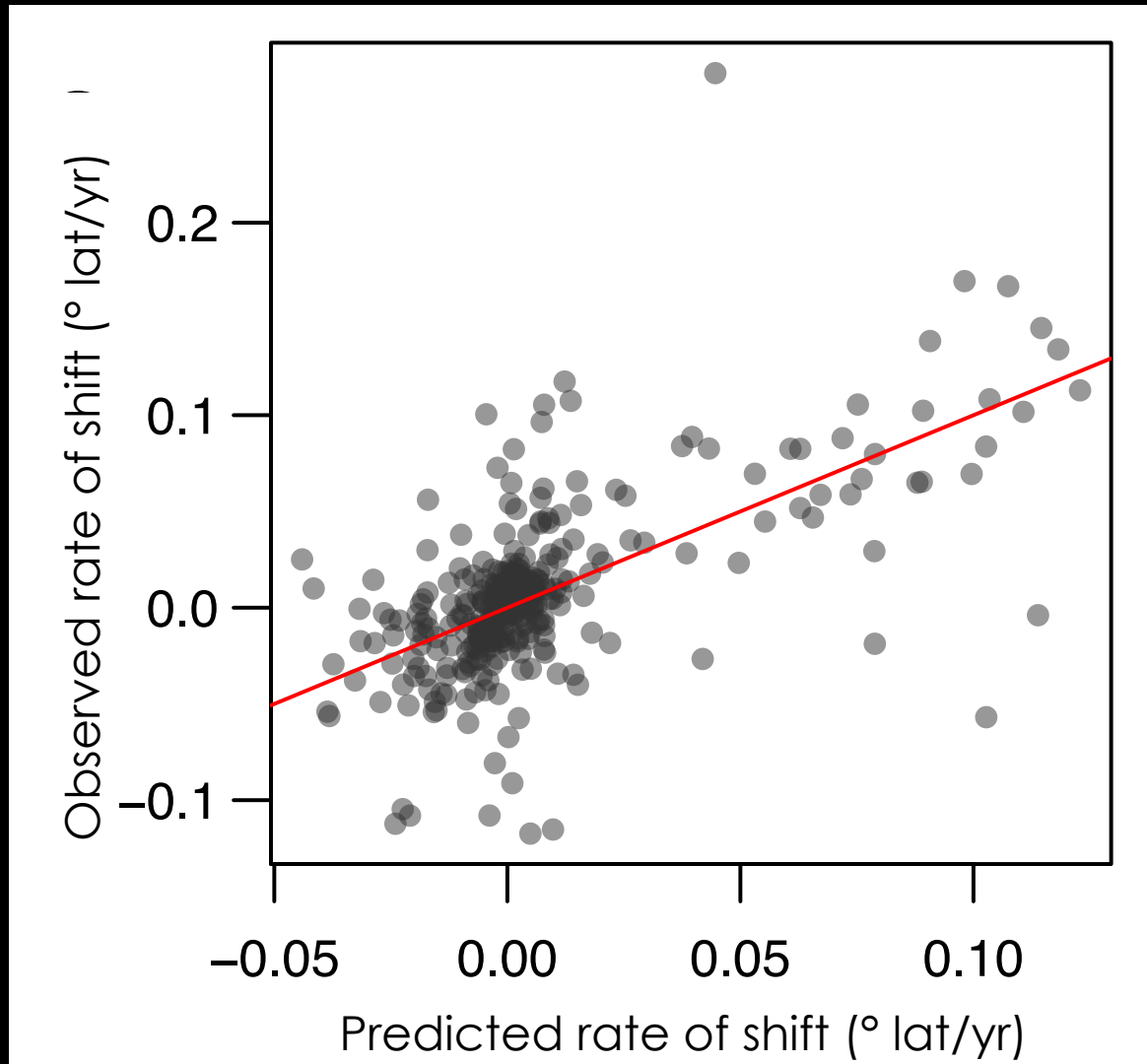
Gulf of Mexico constrained by geography



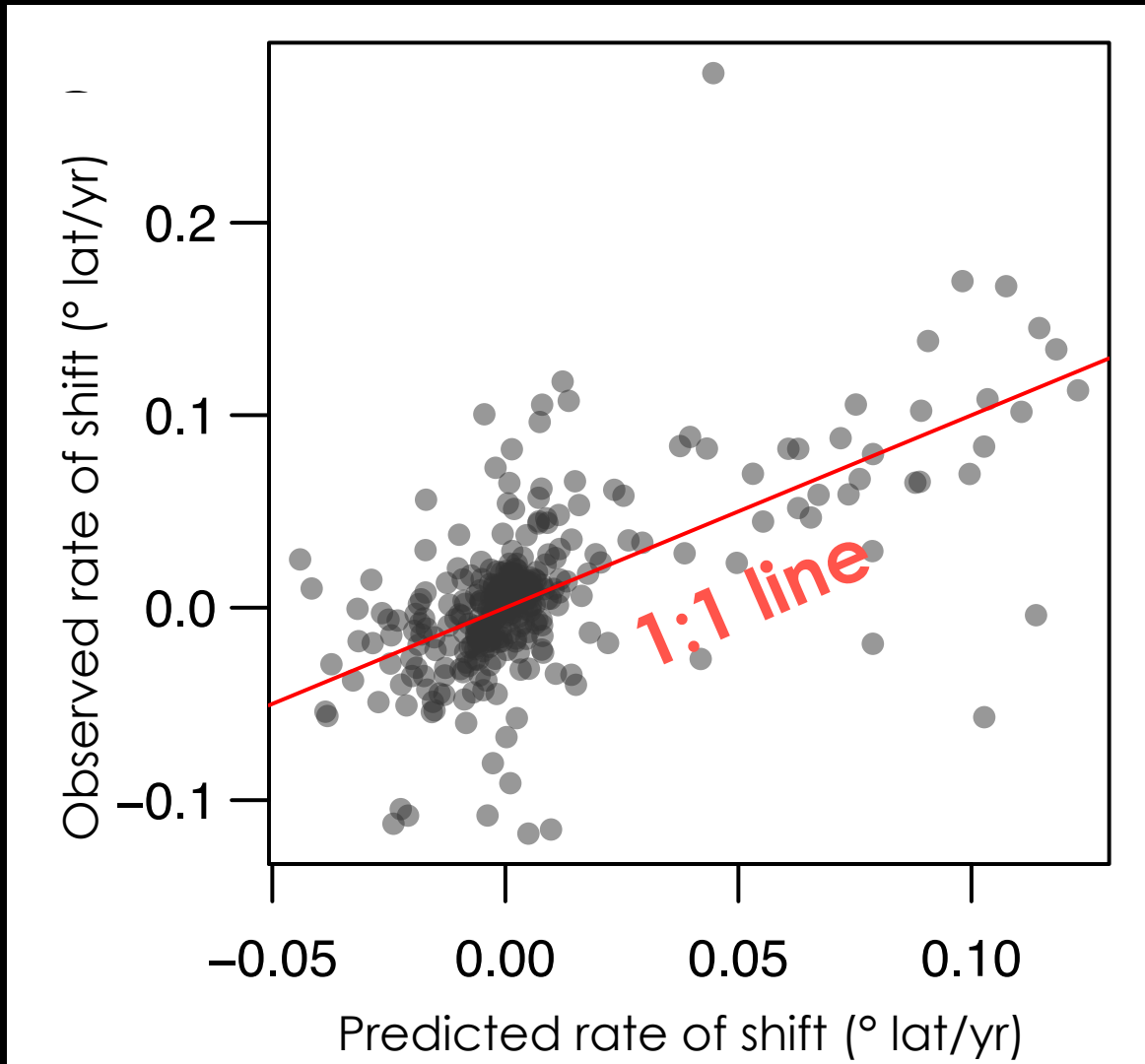
Temperature change explains regional shifts



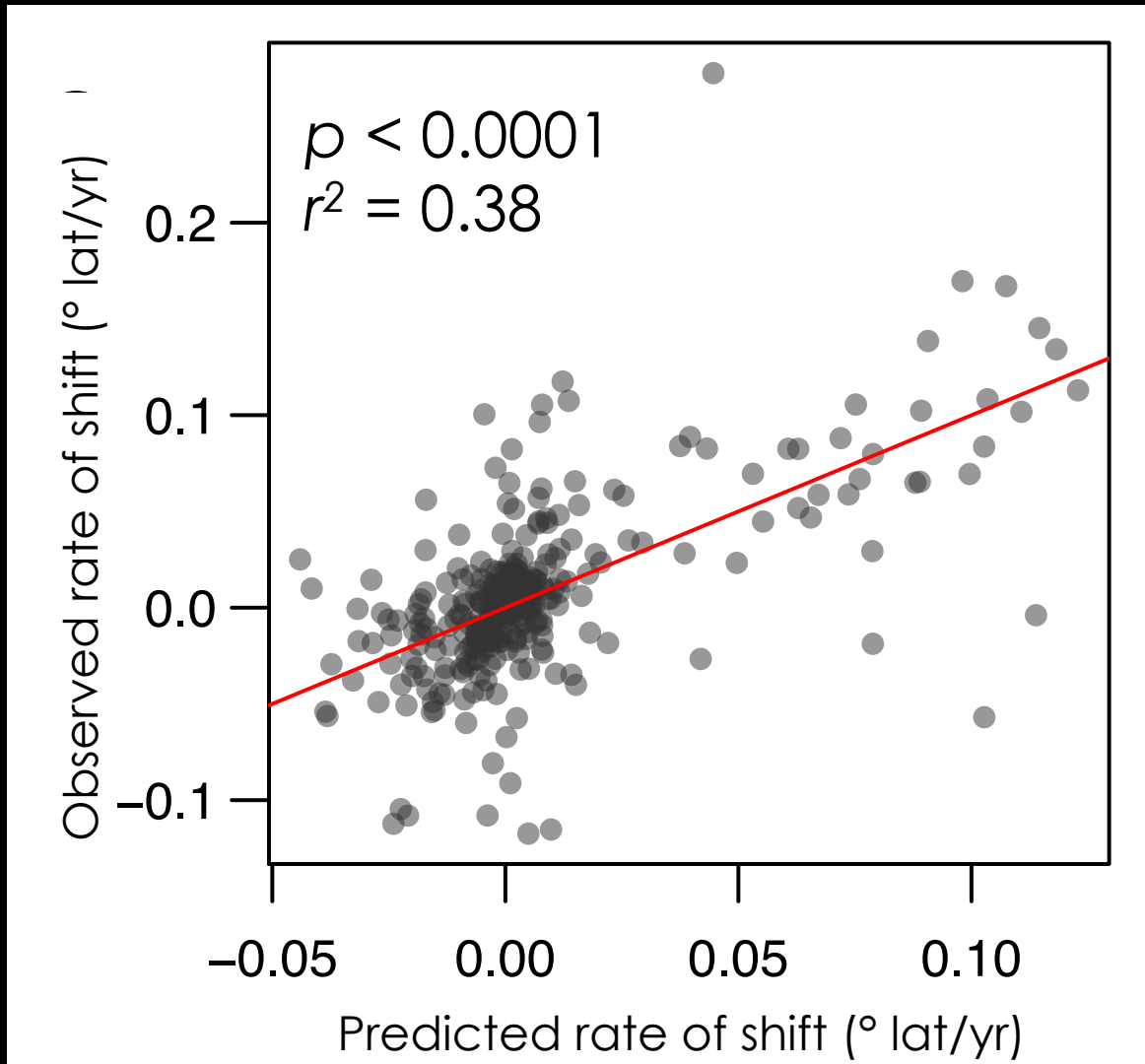
Species follow climate velocity



Species follow climate velocity



Species follow climate velocity



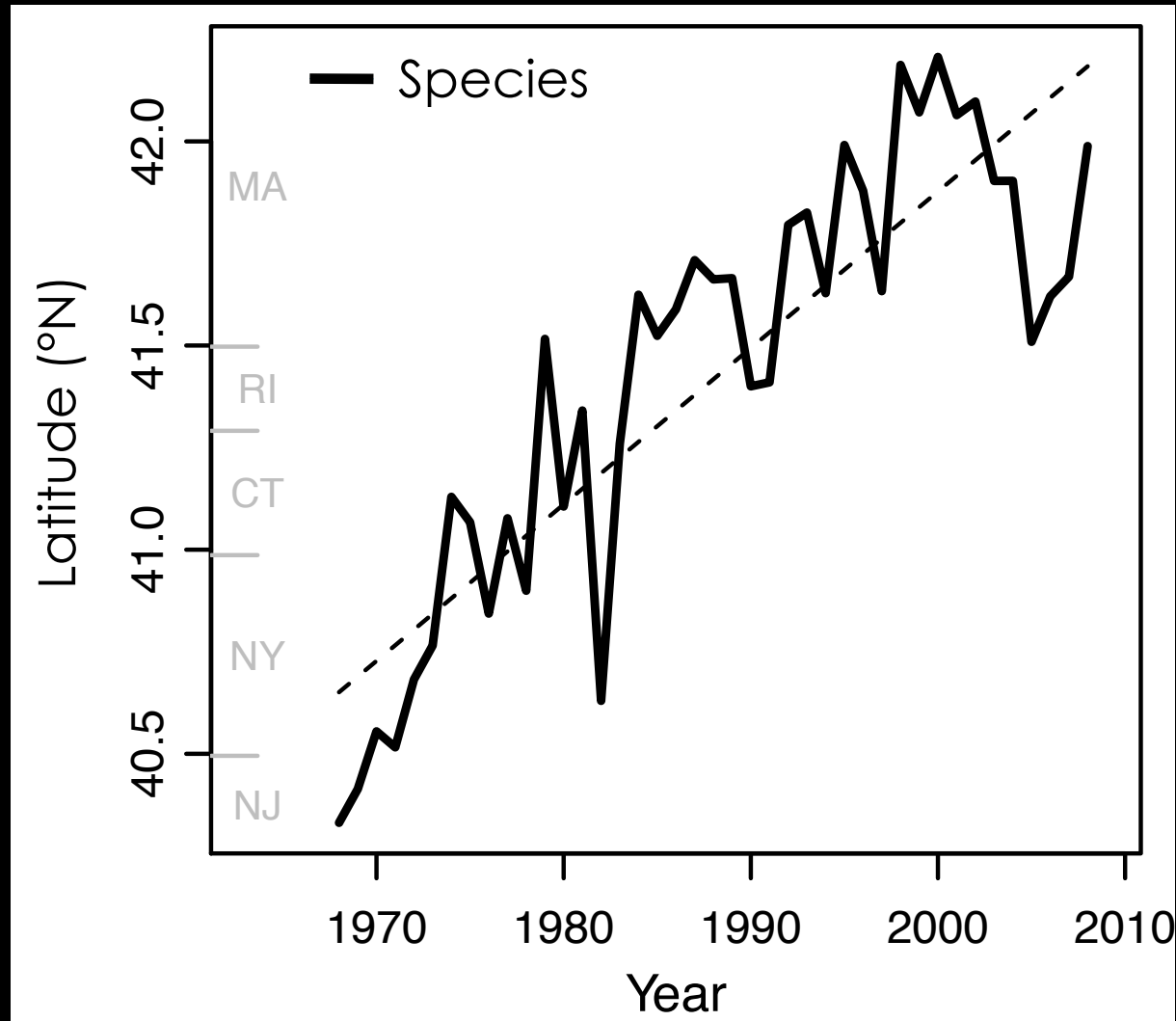
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Rapid poleward shift red hake

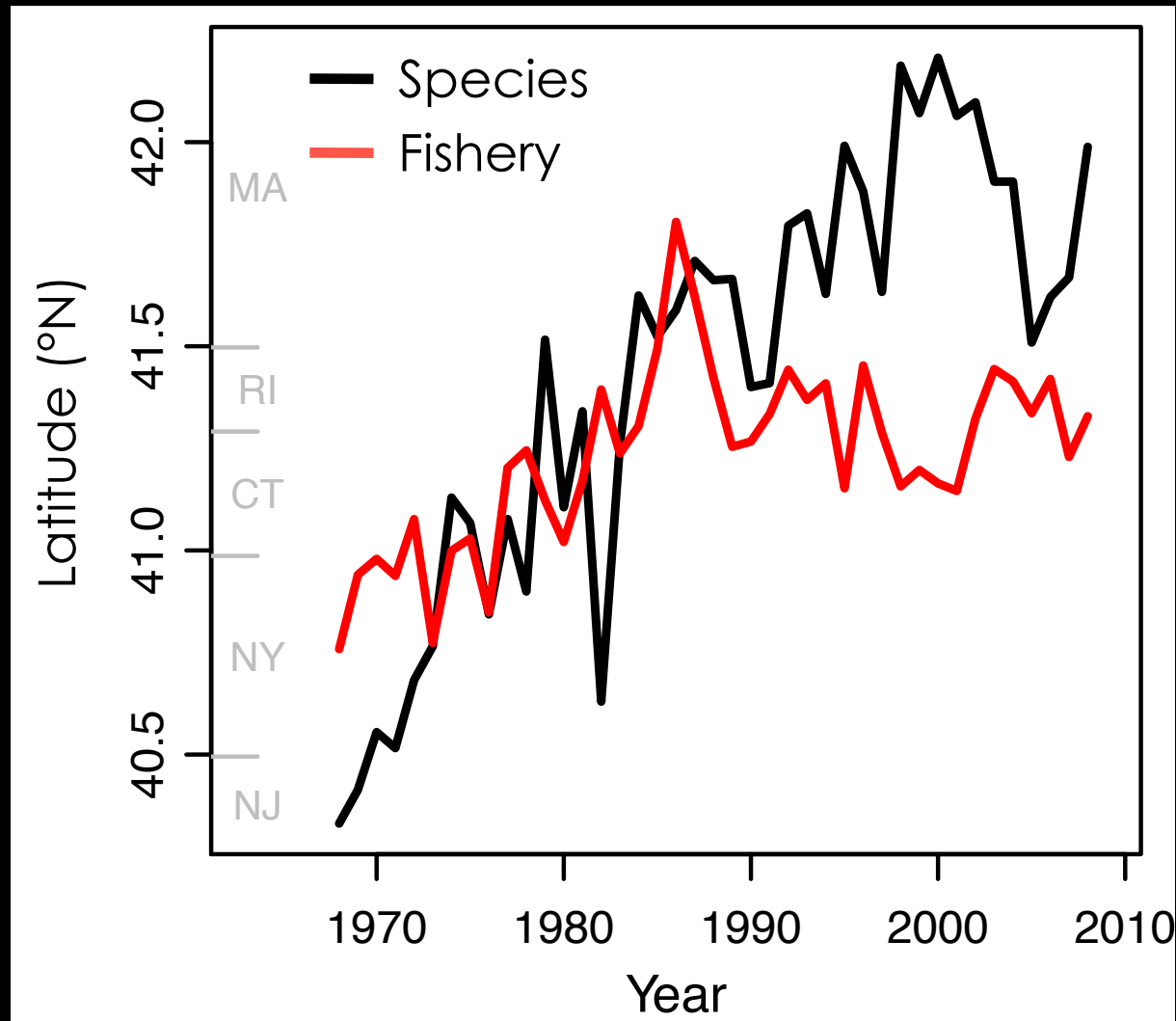


Urophycis chuss



ESD@2002

Fishery landings shift poleward, too

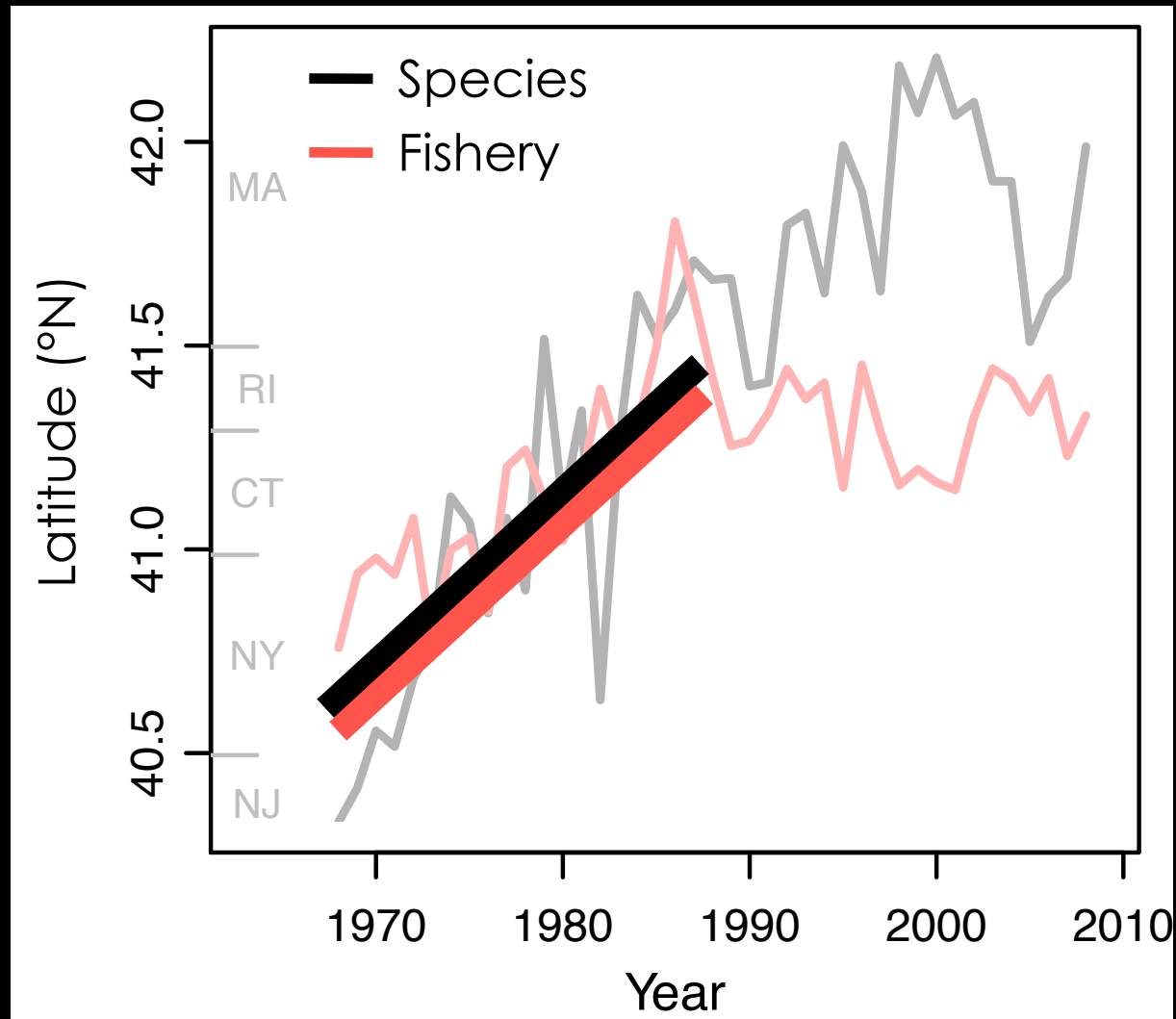


Urophycis chuss

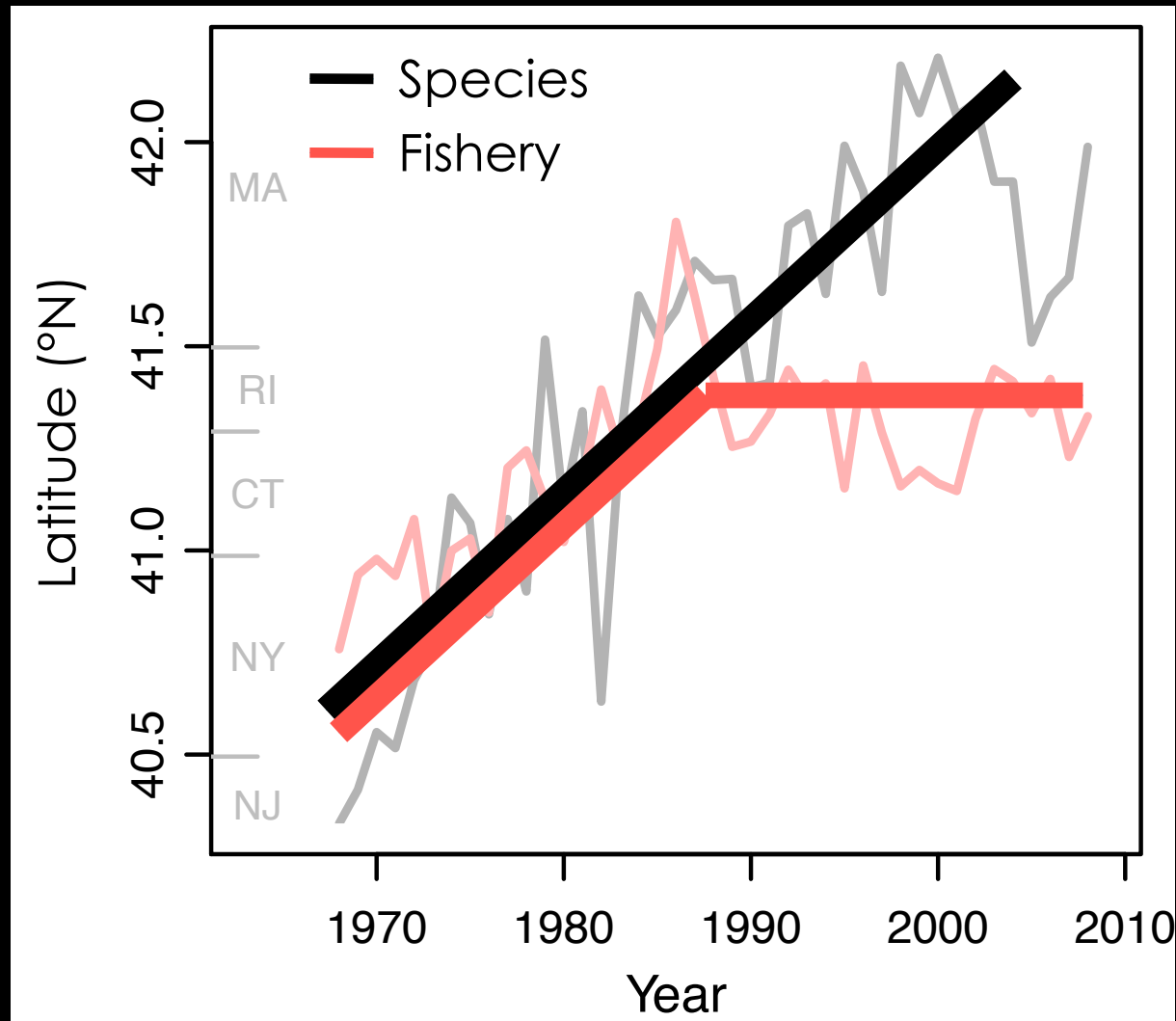


ESD@2002

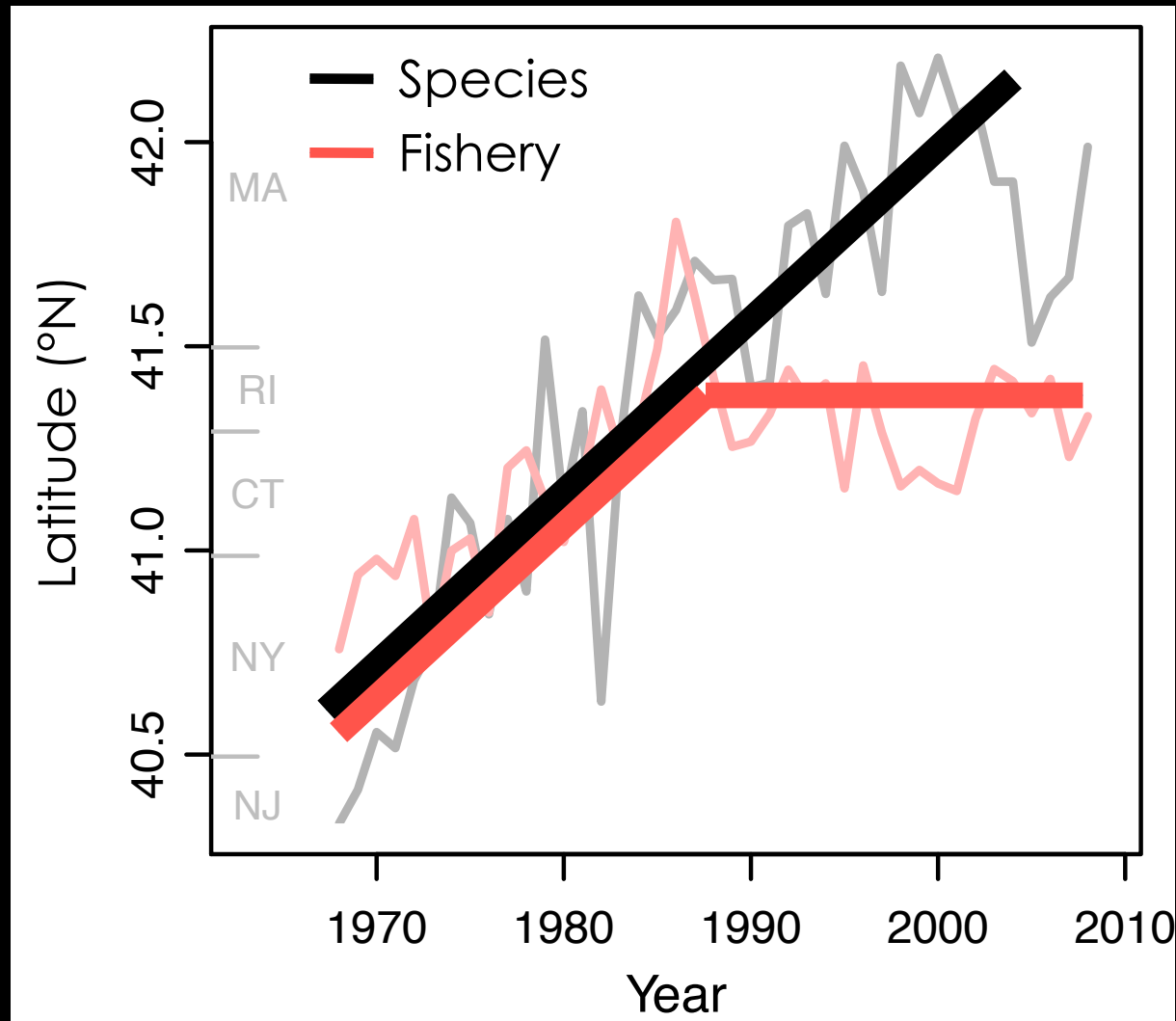
Fishery landings shift more slowly



Fishery landings shift more slowly

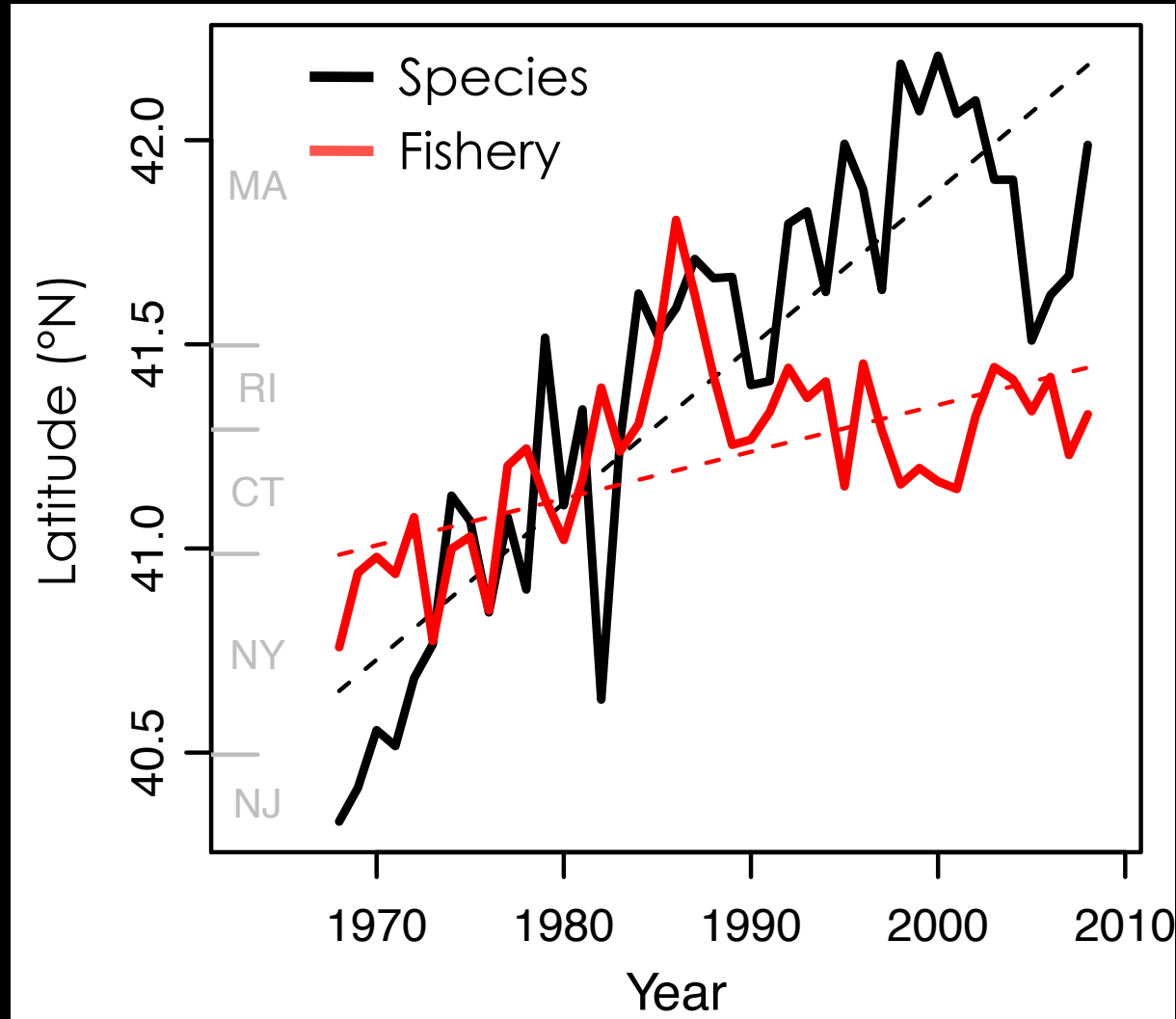


Fishery landings shift more slowly



Nets
excluded
from MA,
NH, ME

Fishery landings shift more slowly



75%
slower

Fisheries lag behind fish

| | |
|---------------------|------------|
| Red hake | 75% slower |
| American lobster | 87% slower |
| Yellowtail flounder | 85% slower |
| Summer flounder | 68% slower |

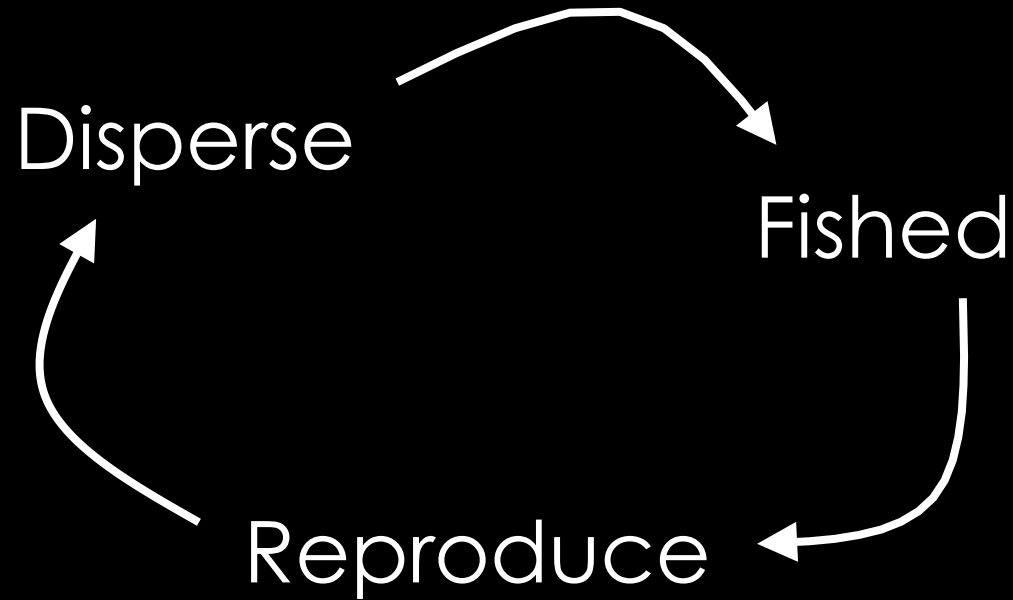
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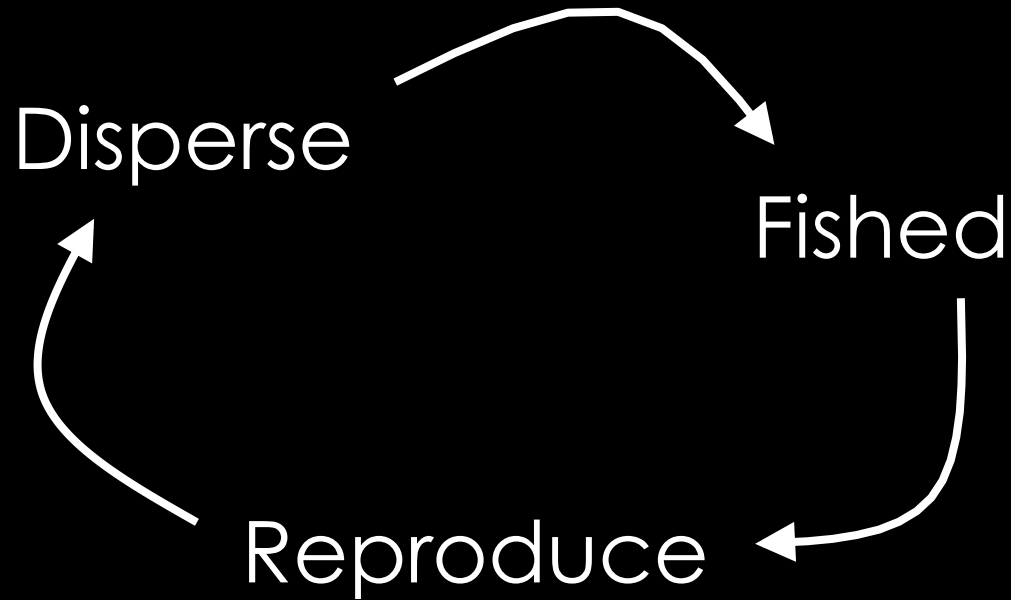
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Model for a species' range



Model for a species' range

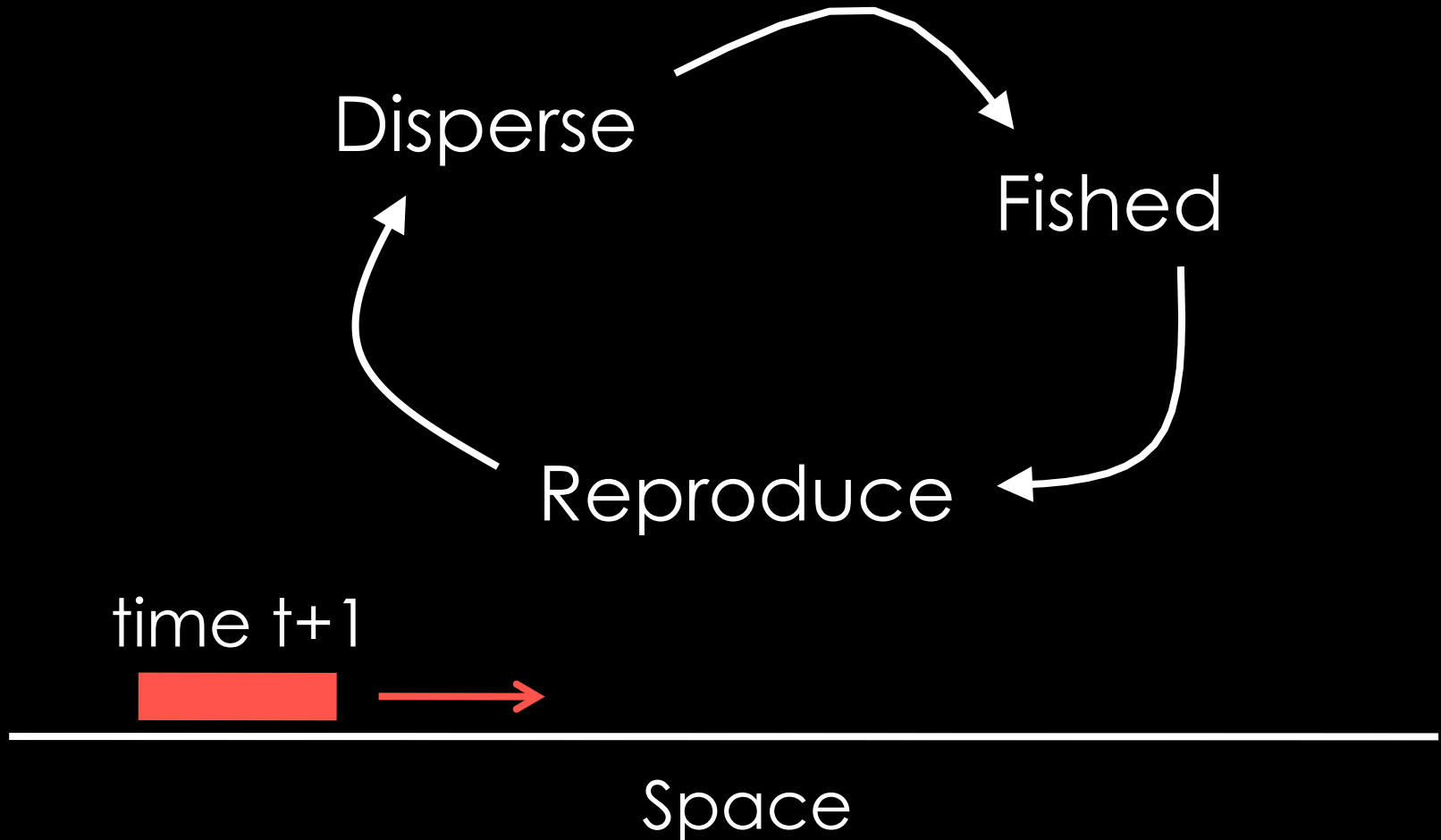


time t

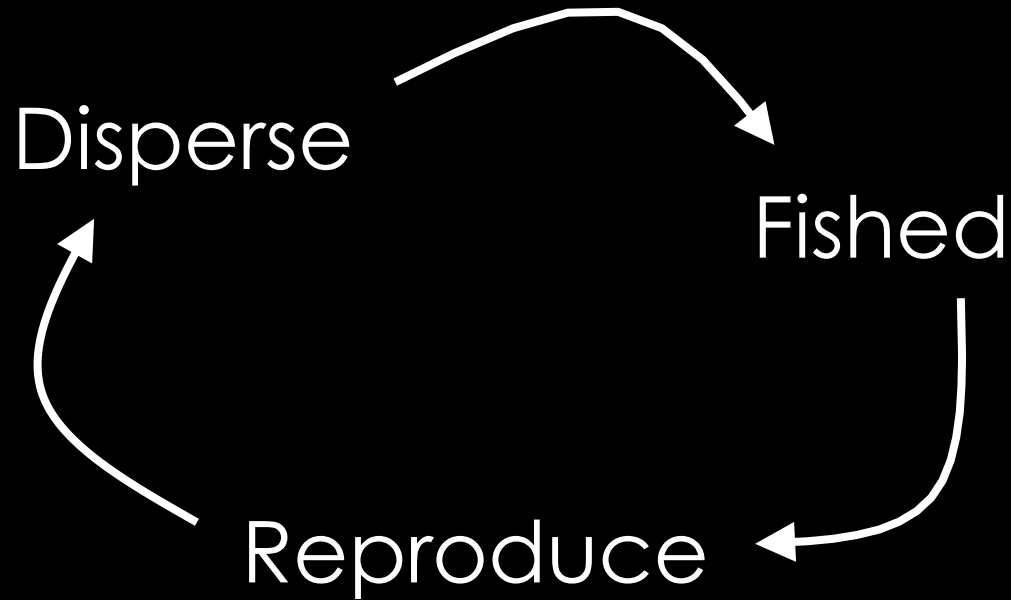


Space

Model for a species' range



Model for a species' range

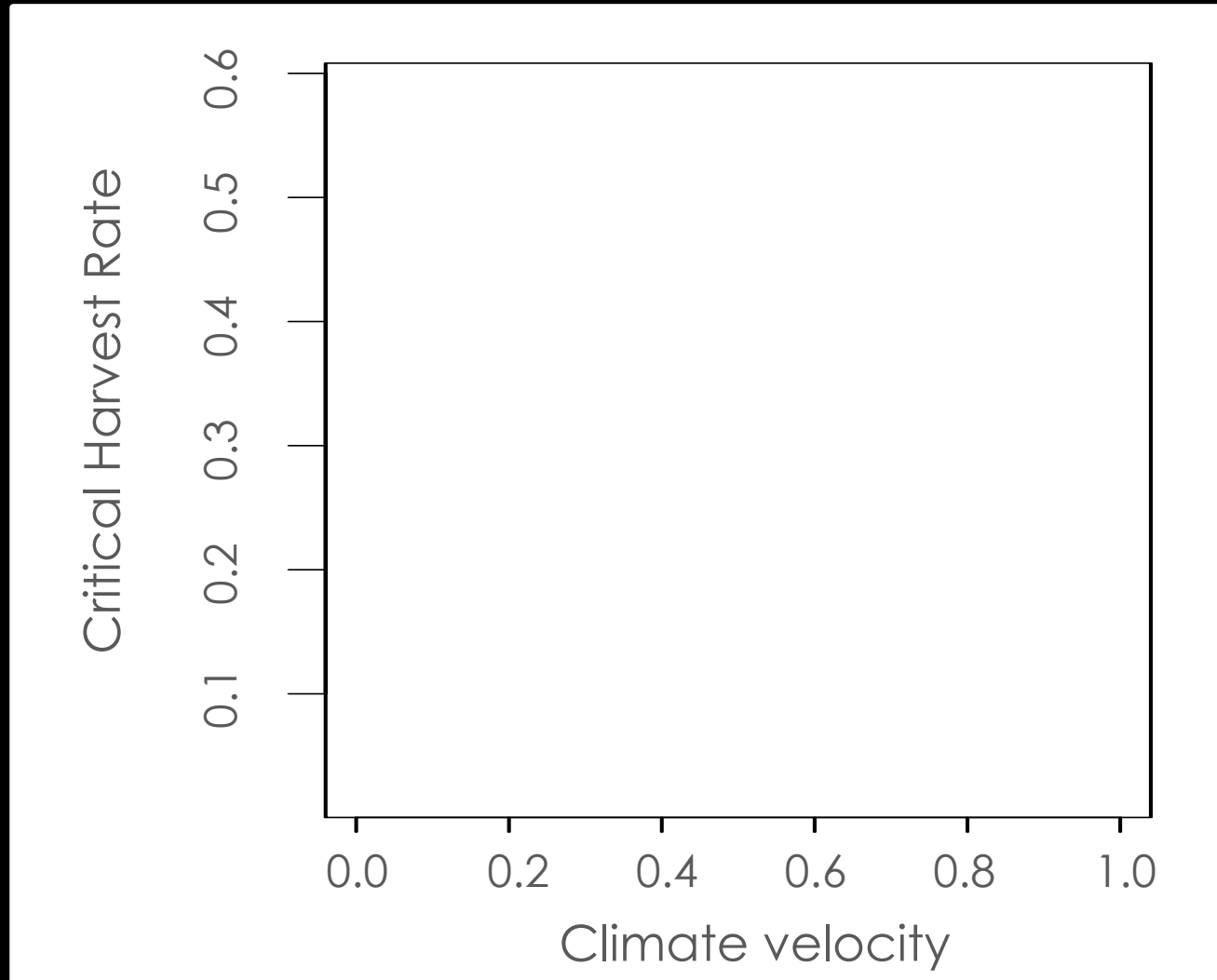


time $t+2$

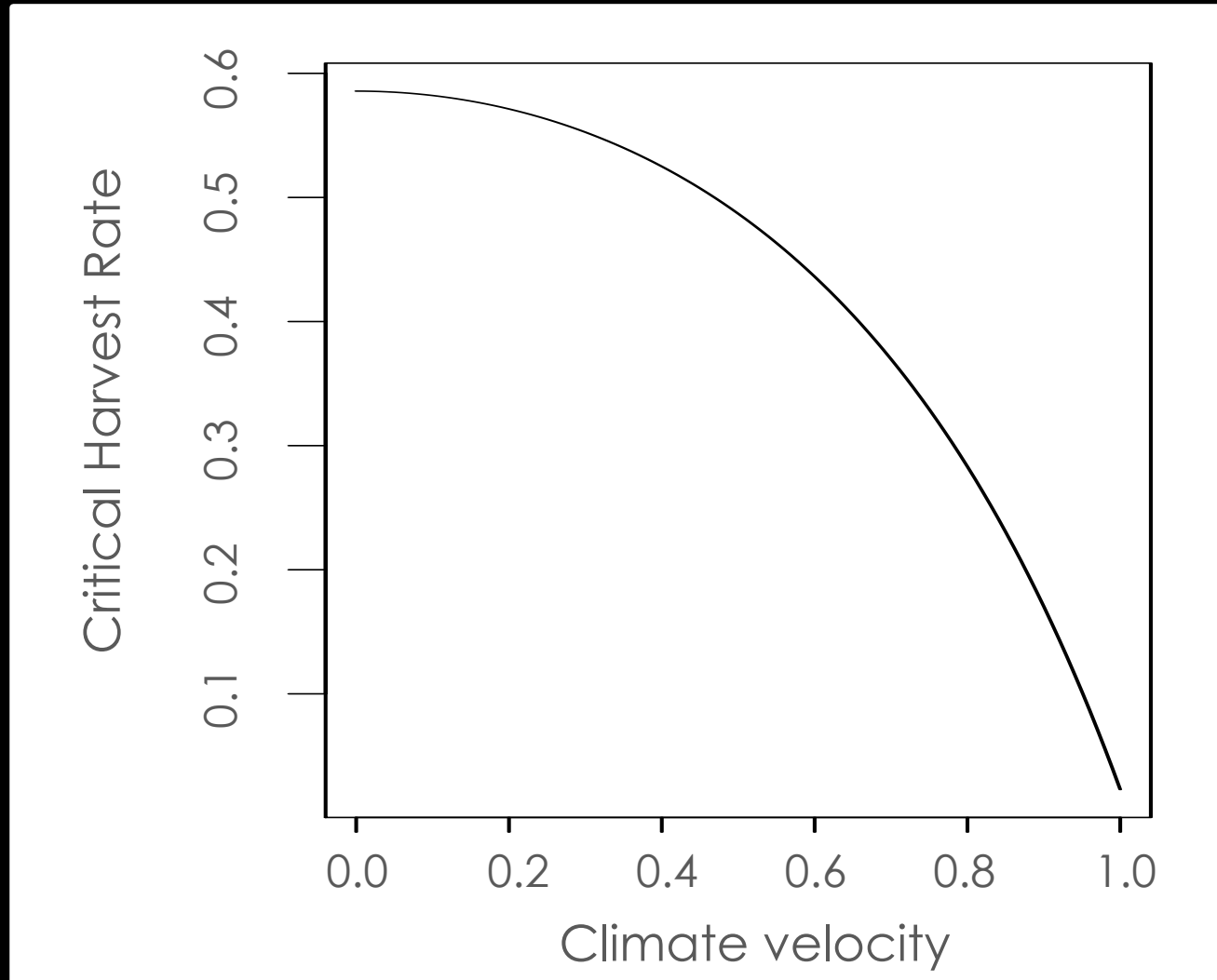


Space

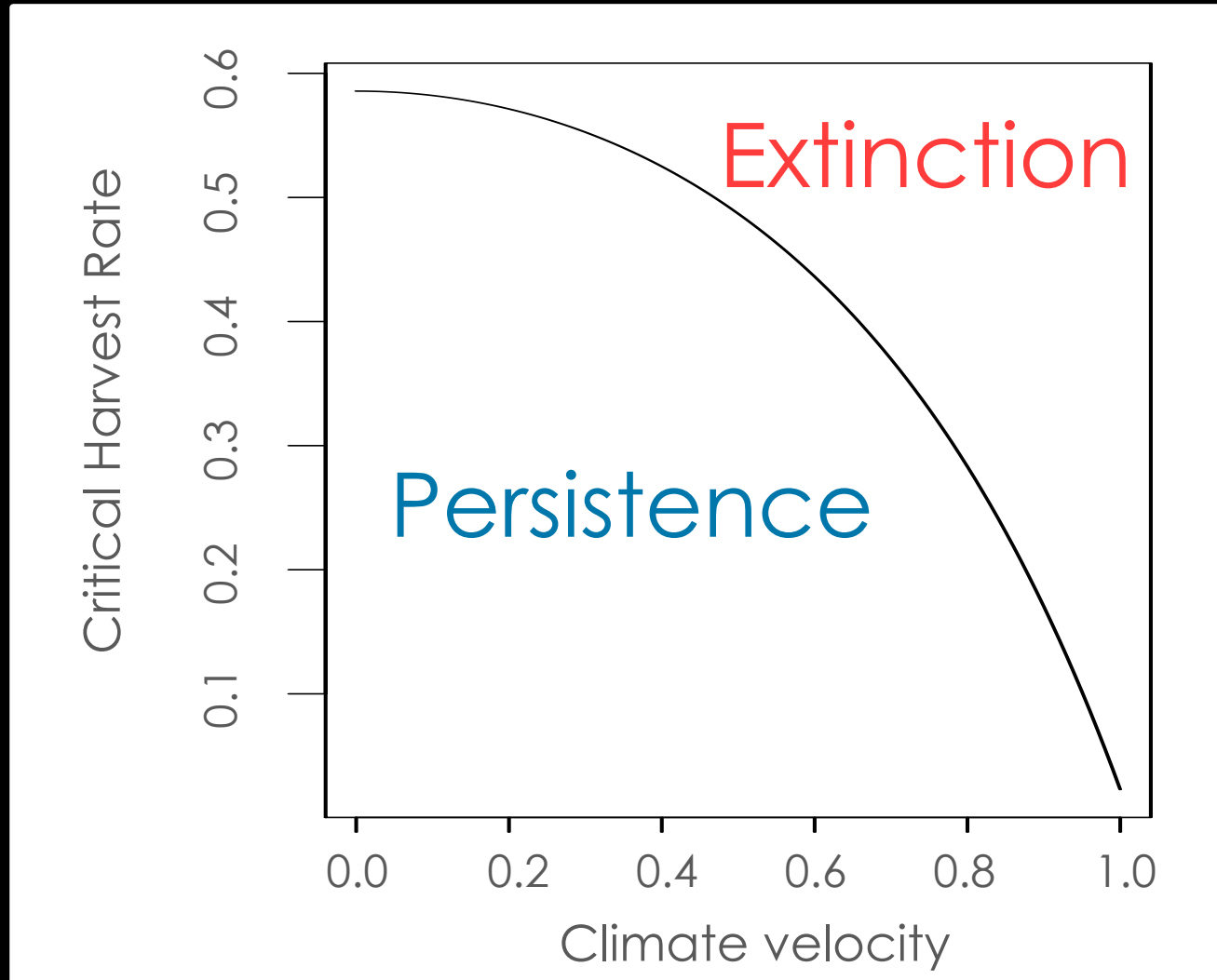
Cumulative impacts



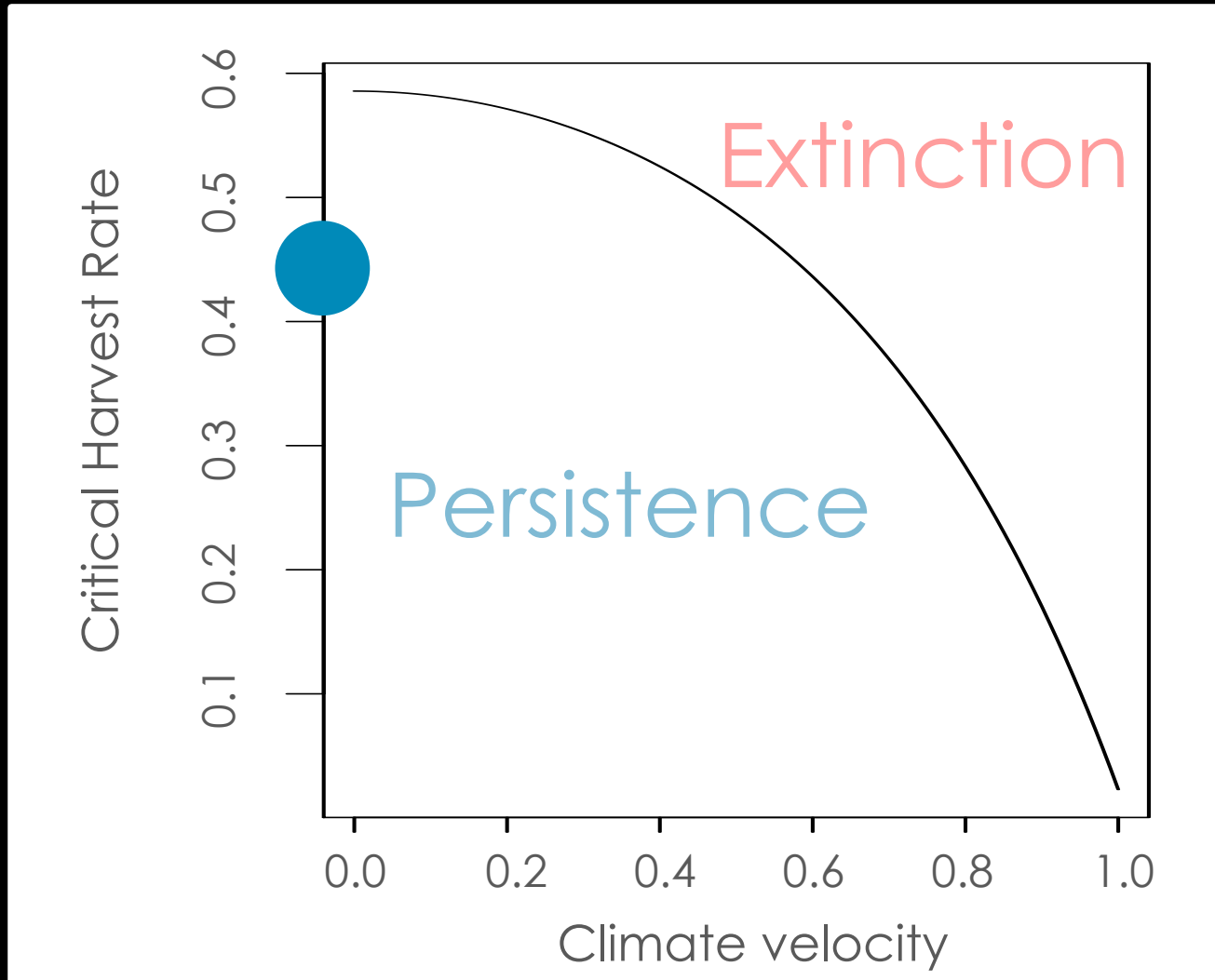
Critical harvest rate



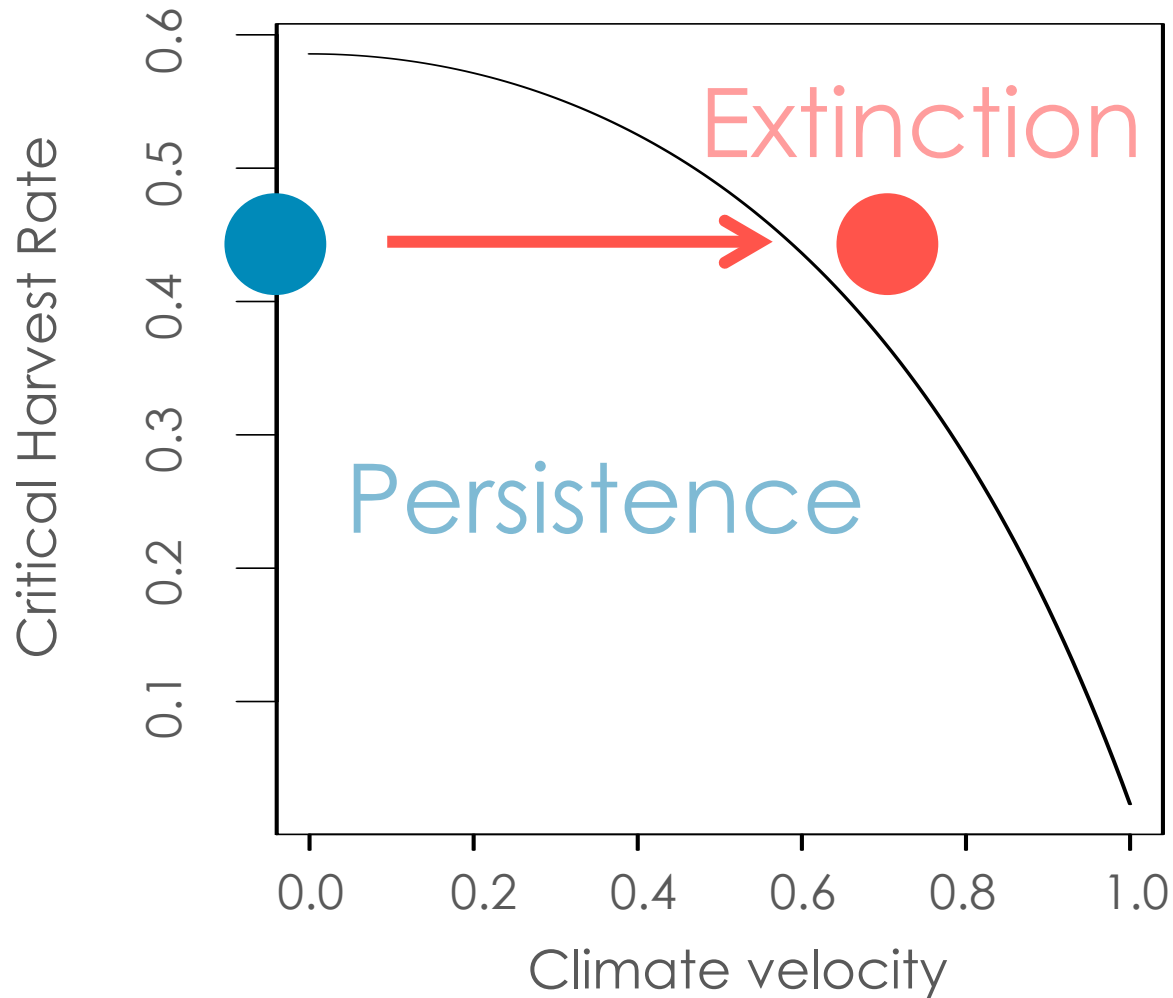
Critical harvest rate



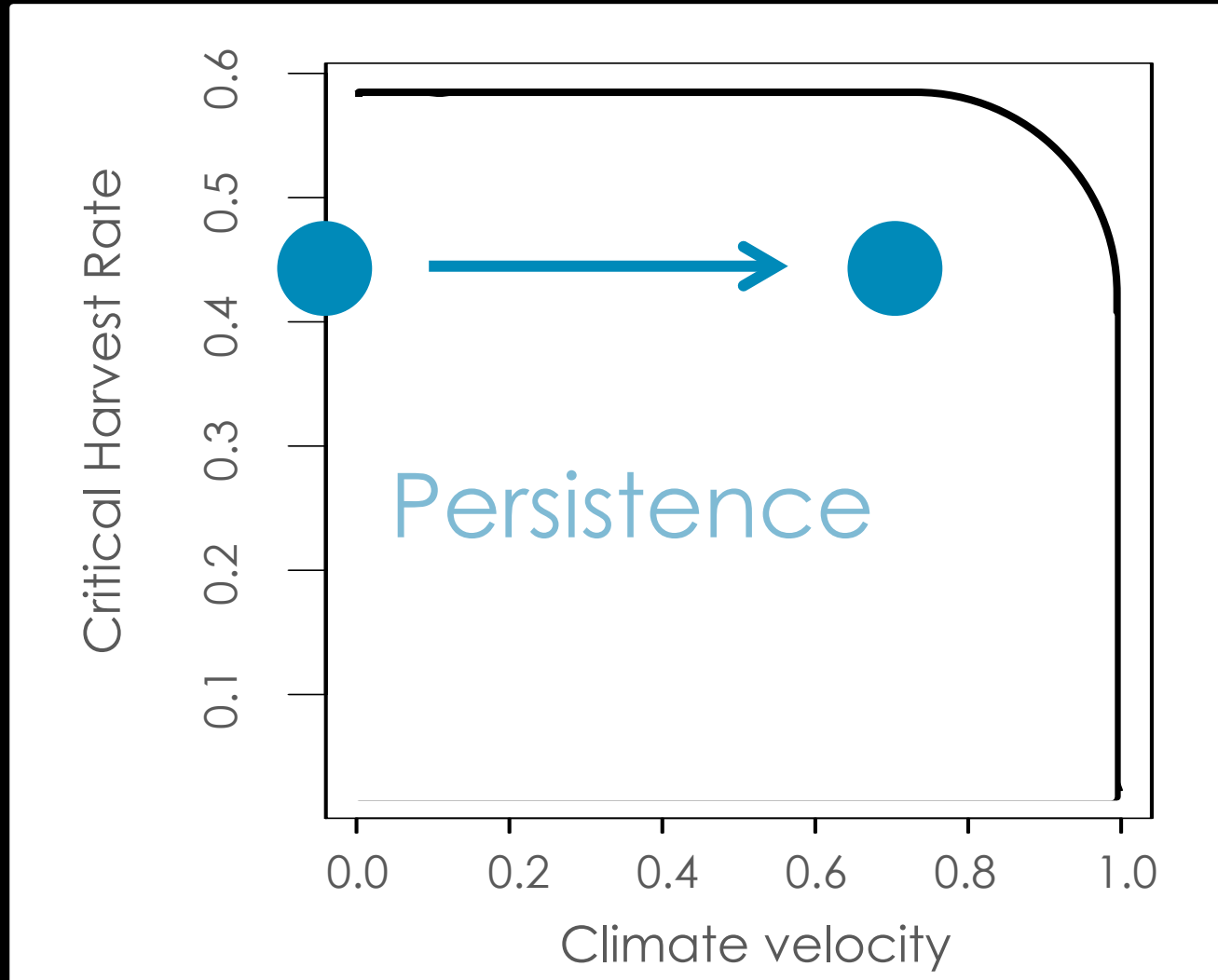
Critical harvest rate



Critical harvest rate



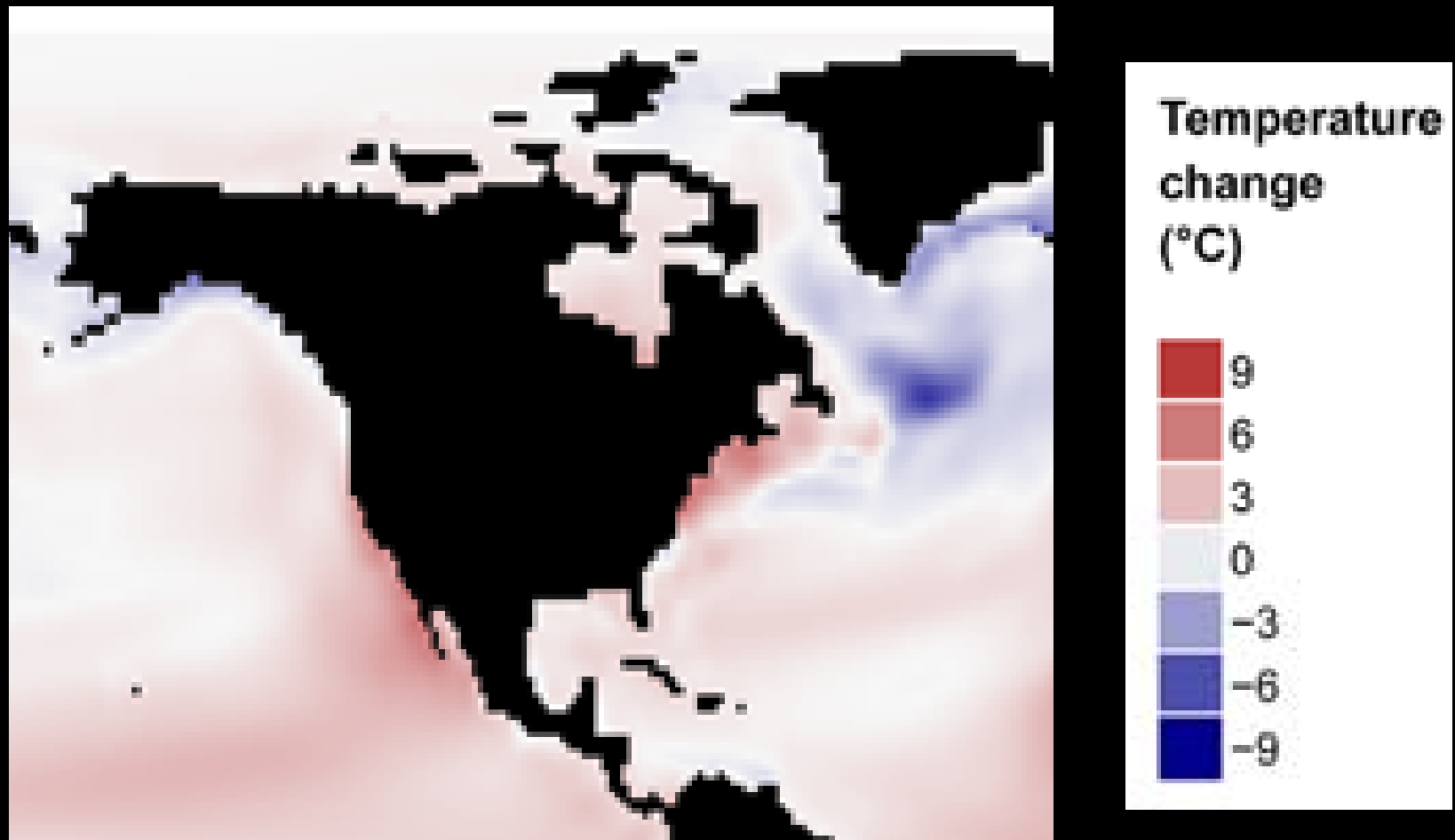
Fishing threshold favors persistence



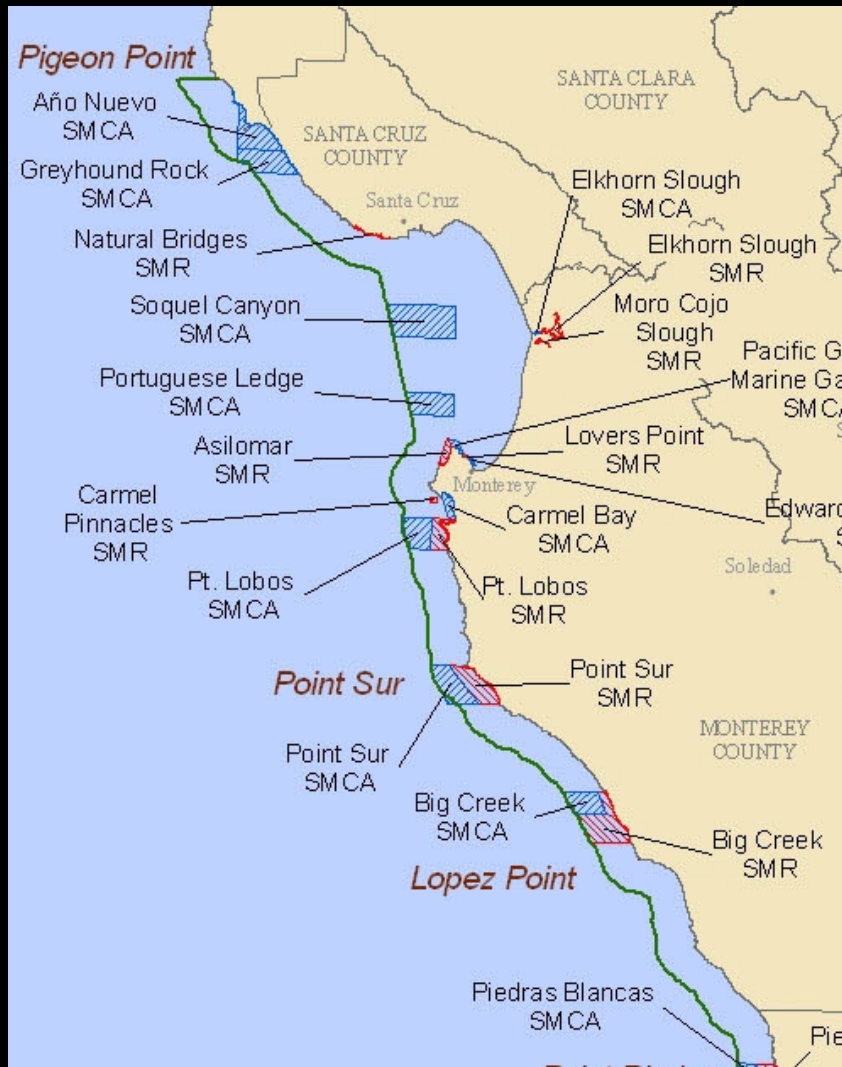
Summary

- Species track climate velocity
- Fisheries follow, but lag behind
- Method of fishery management determines cumulative impact

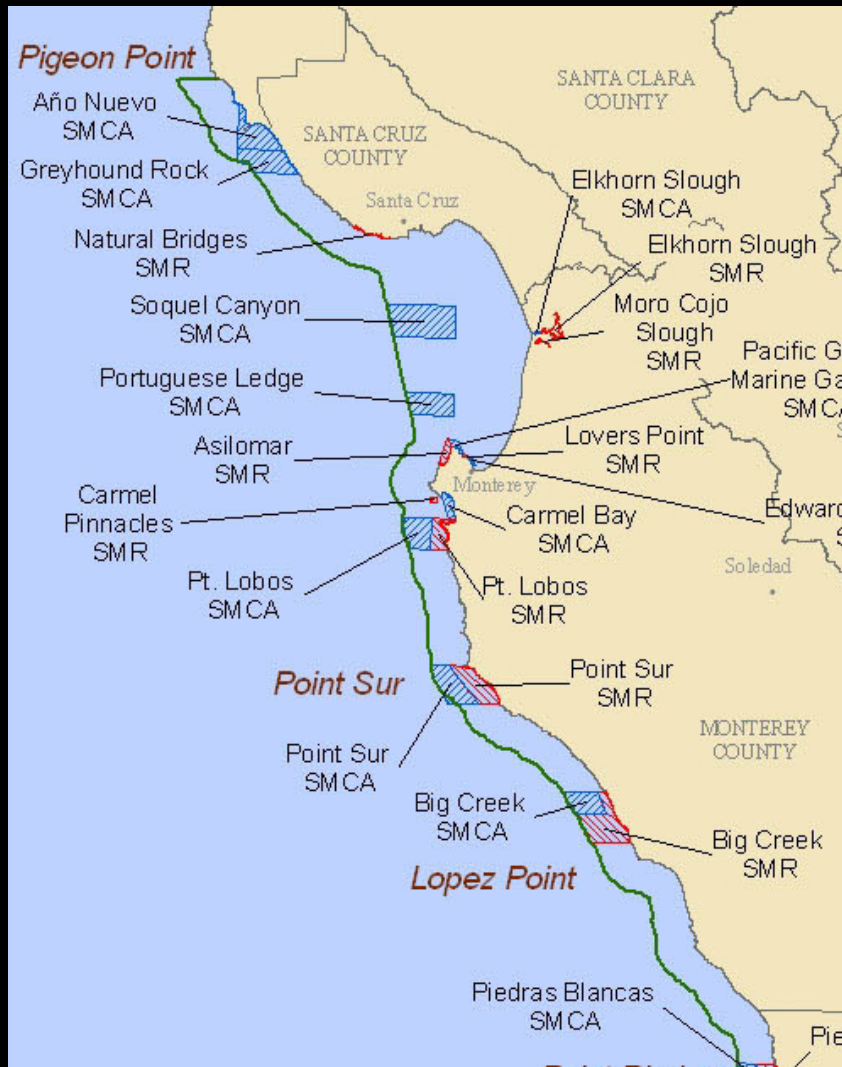
Climate velocity projections



Evaluate conservation plans



Adjust fisheries management



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Summary

- Species track climate velocity
- Fisheries follow, but lag behind
- Method of fishery management determines cumulative impact
- Can use future climate velocity to guide adaptation efforts

Co-authors

- Boris Worm
- Mike Fogarty
- Simon Levin
- Jorge Sarmiento
- Emma Fuller
- Eleanor Brush
- Thomas Froelicher

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- Charlie Stock
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- Bror Jonsson
- Enrique Curchitser
- James Watson

Data



Fisheries and Oceans
Canada

Funding

Smith Fellows 



Society for Conservation Biology